





## Final Report

## SUMMARY REPORT OF HIGHWAY IMPACT STUDIES IN INDIANA

TO: J. F. McLaughlin, Director  
Joint Highway Research Project  
December 13, 1973  
Revised May, 1977

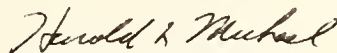
FROM: H. L. Michael, Associate Director  
Joint Highway Research Project  
Project: C-36-64  
File: 3-5

Attached is the Final Report on the HPR Part II Study titled "Highway Impact Studies in Indiana". The Report has been authored by Messrs. Fred Brown and Harold Michael of the JHRP Staff. The Report is the Final Report on this HPR Study whose financing terminated June 30, 1971.

The content of the attached contains nothing new as everything therein has already been presented to the Board, ISHC and FHWA, and accepted by all sponsors, in thirteen (13) earlier reports presented since 1961. This report is simply a summary of the major findings of all phases of this eleven year (1960-1971) study.

The Report is presented for the record and for acceptance with the already accepted thirteen (13) submitted reports as fulfillment of the objectives of this research study.

Respectfully submitted,



Harold L. Michael  
Associate Director

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Final Report  
SUMMARY REPORT OF HIGHWAY IMPACT STUDIES  
IN INDIANA

by

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Project No.: C-36-64

File No.: 3-5

Prepared as Part of an Investigation

Conducted by

Joint Highway Research Project  
Engineering Experiment Station  
Purdue University

in cooperation with the

Indiana State Highway Commission

and the

U.S. Department of Transportation  
Federal Highway Administration

The contents of this report reflect the views of the author who is responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official views or policies of the Federal Highway Administration. This report does not constitute a standard, specification, or regulation.

Purdue University  
West Lafayette, Indiana  
December 13, 1973  
Revised May, 1977



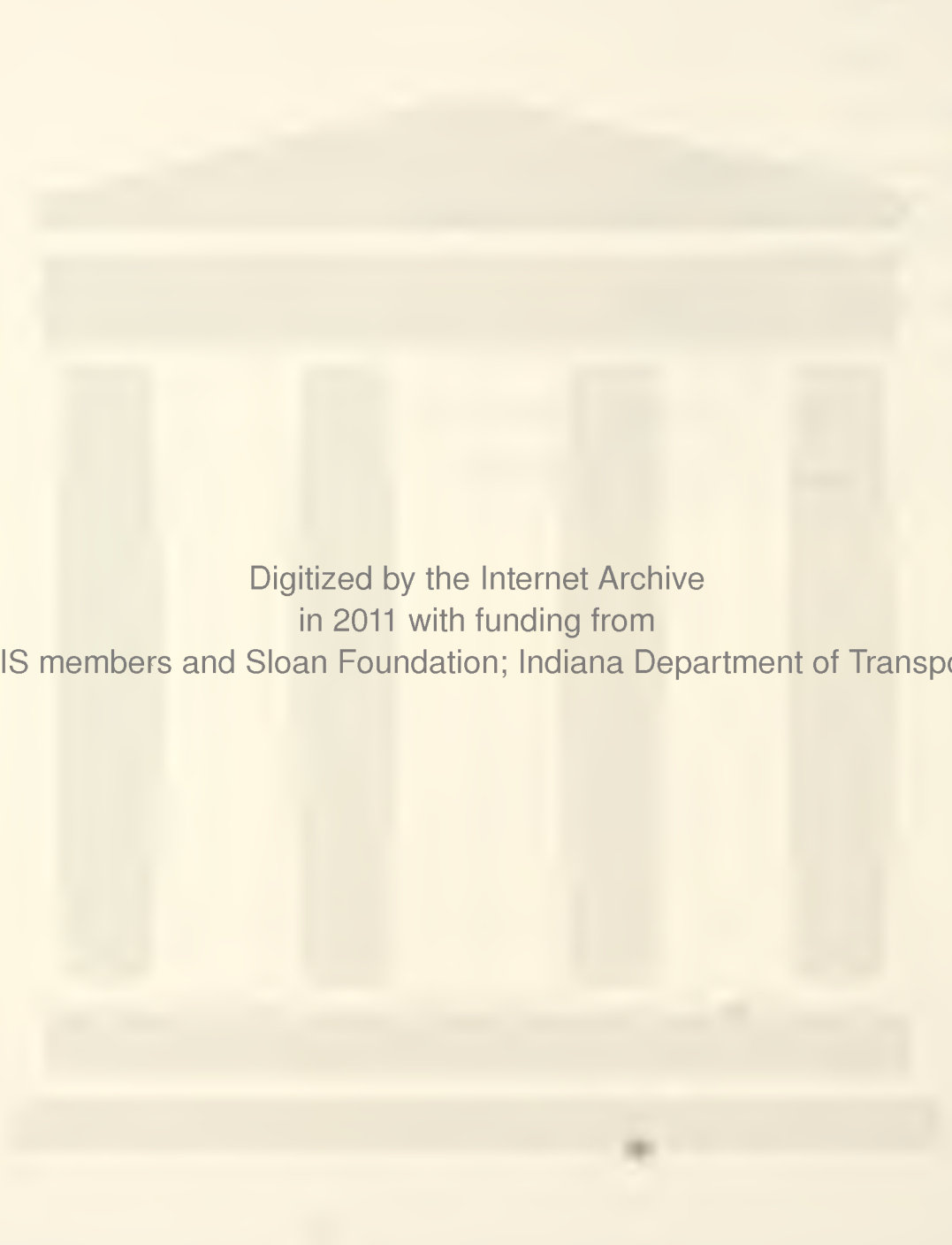
1. Report No. JHRP-73-35	2. Government Accession No.	3. Recipient's Catalog No.	
4. Title and Subtitle SUMMARY REPORT OF HIGHWAY IMPACT STUDIES IN INDIANA		5. Report Date December 1973 (Revised May 1977)	
		6. Performing Organization Code	
7. Author(s) Fred A. Brown and Harold L. Michael		8. Performing Organization Report No. JHRP-73-35	
9. Performing Organization Name and Address Joint Highway Research Project Civil Engineering Building Purdue University West Lafayette, Indiana 47907		10. Work Unit No.	
		11. Contract or Grant No. HPR-1(8) Part II	
12. Sponsoring Agency Name and Address Indiana State Highway Commission 100 North Senate Avenue Indianapolis, Indiana 46204		13. Type of Report and Period Covered Final Report	
		14. Sponsoring Agency Code	
15. Supplementary Notes Prepared in cooperation with the U.S. Department of Transportation, Federal Highway Administration on Research Study titled "Highway Impact Studies".			
16. Abstract This Report presents a summary of thirteen (13) earlier reports submitted on this ten-year research project. The summary is reported under six (6) topic areas as follows: <ol style="list-style-type: none"> <li>1. Impact of Remainder Parcels</li> <li>2. Early Impact of a Rural Highway with Complete Control of Access</li> <li>3. Impact of Small City Bypasses</li> <li>4. Impact of a New River Crossing in a Small City</li> <li>5. Modeling the Impact of Highway Improvements</li> <li>6. Impact of a Major Interstate Interchange</li> </ol>			
17. Key Words Highway Impact; Land Value; Urban Area Development; Land Value Impact; Land Use Impact		18. Distribution Statement No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161	
19. Security Classif. (of this report) Unclassified	20. Security Classif. (of this page) Unclassified	21. No. of Pages	22. Price





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## INTRODUCTION

Transportation systems have played an indispensable role in the development of our civilization. They have enabled our technology to keep pace with the rising tide of man's expectations and needs. They have helped to stimulate interactions between man and his environment and they have served as an impetus to economic activity. Transportation improvements have become one of the greatest catalysts of change in our economic, social, and political institutions. Thus in transportation planning, we are concerned about the "impact" that a highway improvement will have. This "impact" is made up of the aesthetic, social, political, and economic impacts on the surrounding area. Each of these is important and there exist some correlations between all of them.

The purpose of a transportation improvement is to meet a demand for the more efficient movement of goods and people. Transforming expressed transportation needs into a transportation system which meets these needs is subject to technological, monetary, resource, political, and physical constraints. Thus transportation planners need only find the best combination of resources satisfying these constraints. But the planner must also look ahead to see what effect this improvement will have. Impact studies are designed to supply facts about past decisions so as to facilitate decision making in the future.

In recognition of the useful knowledge that can be gained from impact studies, the American Association of State Highway Officials passed a resolution at their annual business meeting in November 1956 urging all state highway departments to promote research into the economic impact of highway improvements. In addition, they called upon the Highway Research Board to sponsor a conference with the sole objective of discussing this matter.

The Highway Research Board, in accepting this recommendation, assembled most of the noted experts in the area of economic impact of highways. The momentum generated at this conference sparked much interest in this area among several state highway departments. By 1960, one hundred studies had been reported and more than forty additional investigations in twenty-nine states were under way. In these investigations, the Bureau of Public Roads and the state highway departments, working closely with many universities,



attempted to delineate the various impacts accruing to communities from different types of highway improvements. Purdue University, the State Highway Commission of Indiana, and the Bureau of Public Roads cooperated in such an investigation.

On July 1, 1960, a planned, ten year program on impact research was undertaken by the Joint Highway Research Project at Purdue University. This project was designed to provide information on the effects of highway improvements on adjacent areas, including land use changes, land value changes, and changes in the characteristics of highway travel. Such information was to provide for a more efficient and economical approach for locating future highways.

A total of six specific types of highway improvements were originally proposed as the study areas. These facilities were:

- Facility 1. An urban by-pass with complete access control;
- Facility 2. A rural highway with complete access control;
- Facility 3. An urban by-pass with little or no access control;
- Facility 4. A rural highway with little or no access control;
- Facility 5. A bridge and its approaches in an urban area;
- Facility 6. A major highway interchange near a metropolitan area.

The specific facilities corresponding to the types of improvements listed above were planned to be:

- Facility 1. The Interstate 65 by-pass around Lebanon, Indiana;
- Facility 2. A thirteen mile portion of Interstate 65 from the south end of the Lebanon By-pass to the interchange with Interstate 465 northwest of Indianapolis, Indiana;
- Facility 3. The U.S. 31 by-pass around Kokomo, Indiana;
- Facility 4. U.S. 31 from the south end of the Kokomo By-pass to the north edge of Marion County, Indiana;
- Facility 5. The U.S. 231 Bridge over the Wabash River connecting Lafayette and West Lafayette, Indiana;
- Facility 6. The interchange connecting Interstate 65 and Interstate 465 northwest of Indianapolis, Indiana.

The location of the facilities are shown in Figure 1.



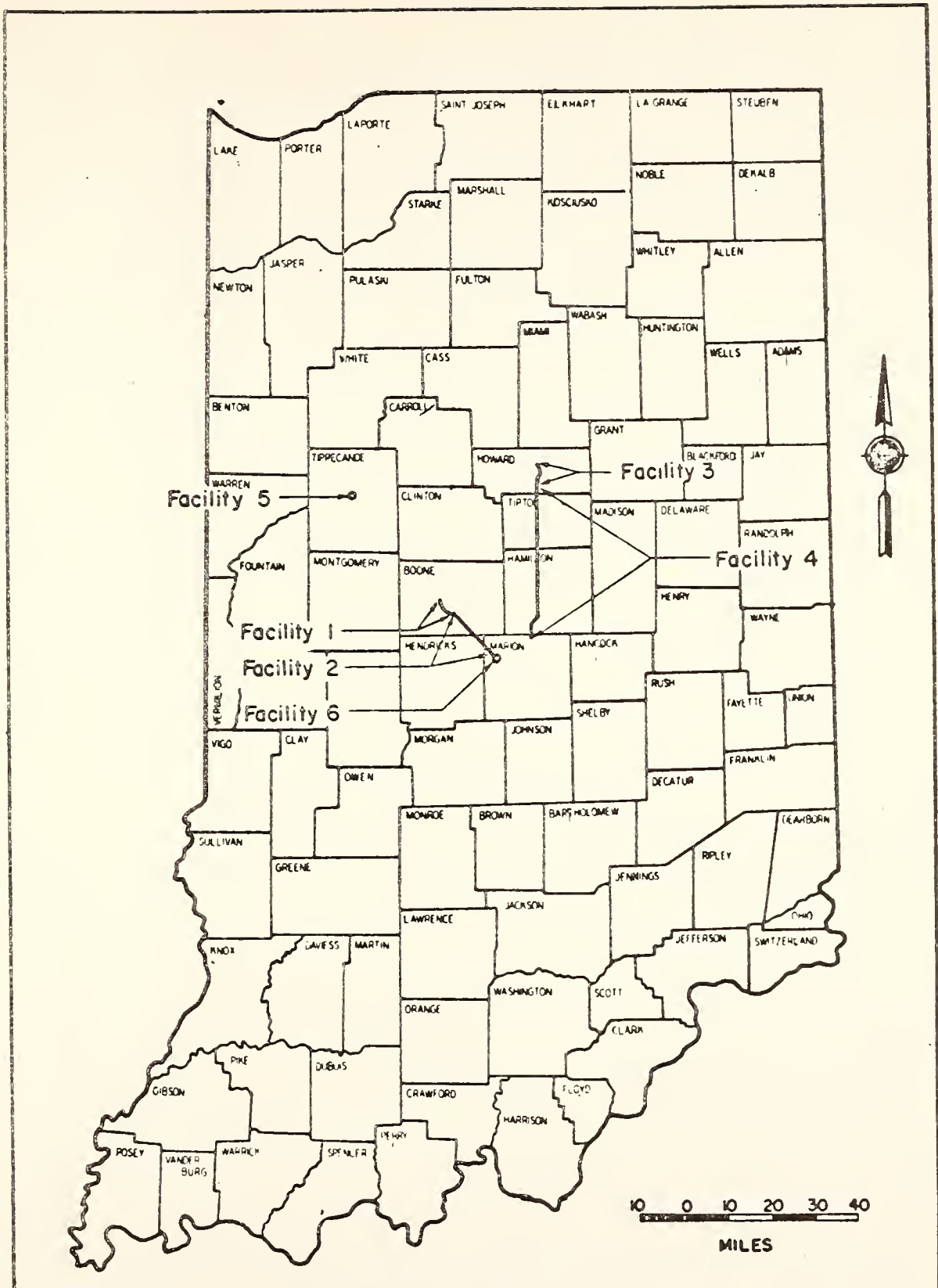


Figure 1. Location of Facilities.





The Interim Reports which have been submitted on this Study with indication as to the above facility with which they deal if appropriate are as follows:

1. "Studies of Highway Impact in Indiana: Development of the Studies", Interim Report, JHRP-61-17, J. A. Fletcher and H. L. Michael, June 1961.
2. "Studies of Highway Impact in Indiana: Early Effects of a Portion of Interstate 65", Interim Report, JHRP-61-18, J. A. Fletcher, June 1961 (Facility 2).
3. "Studies of Highway Impact in Indiana: A Study of Partial Takings for a Portion of Interstate 65", Interim Report, JHRP-61-19, J. A. Fletcher, June 1961 (Facility 2).
4. "Early Impact of a Highway Improvement on an Urban Area", Interim Report, JHRP-62-14, Alan F. Lohr, May 1962 (Facility 5).
5. "A Study of Remainder Parcels Resulting from the Acquisition of Highway Rights-of-Way - Part I - Analyses", Interim Report, JHRP-63-22, V. G. Stover, Sept. 1963.
6. "A Study of Remainder Parcels Resulting from the Acquisition of Highway Rights-of-Way - Part II - Case Studies", Interim Report, JHRP-63-23, V. G. Stover, Sept. 1963.
7. "Land Economic Studies in Indiana", Technical Paper, JHRP-63-28, V. G. Stover, Sept. 1963.
8. "Impact of Lebanon Bypass 1950-1963", Interim Report, JHRP-64-29, R. J. Hensen, H. L. Michael and J. S. Matthias, Oct. 1964 (Facility 1).
9. "Impact of Kokomo Bypass from 1950 to 1964", Interim Report, JHRP-65-11, E. G. Evans, Aug. 1965 (Facility 3).
10. "Impact of Kokomo Bypass from 1950 to 1964", Technical Paper, JHRP-65-16, E. G. Evans and H. L. Michael, Sept. 1965 (Facility 3).
11. "The Impact After Seven Years of a Highway Improvement in a Small City", Interim Report, JHRP-68-8, E. R. Fleischman, May 1968 (Facility 5).
12. "Modeling the Impact of Highway Improvements on the Value of Adjacent Land Parcels", Interim Report, JHRP-69-37, E. I. Isibor, Dec. 1969.
13. "The Impact on Land Value of a Major Highway Interchange Near a Metropolitan Area", Interim Report, JHRP-73-34, F. A. Brown and H. L. Michael, Dec. 1973 (Facility 6).





Each of the above Reports was accepted by all sponsors as partial fulfillment of the objectives of the Study. Some of the analysis procedures used in the last Report indicated above, however, were questioned by FHWA and that Report was not approved for publication as sponsored by FHWA. As a result, the name of FHWA as a sponsoring organization was not included in the limited number of copies prepared.

During progress of the Study, it became evident that little impact was occurring on Facility 4, a rural highway with little or no access control. The facility was a connection through agricultural land between urban areas and land use changed very little during the study period. As a result, little benefit from a detailed study of the facility would have resulted and study of impact on Facility 4 was dropped from the Study.

The Study contributed to six topical areas in the highway impact area. A summary of the findings of this "Highway Impact Studies" research project is herein reported as the Final Report on this research under these six topic areas, as listed below, in the sections which follow:

1. Impact on Remainder Parcels
2. Early Impact of a Rural Highway with Complete Access Control
3. Impact of Small City Bypasses
4. Impact of a New River Crossing in a Small City
5. Modeling the Impact of Highway Improvements
6. Impact of a Major Interstate Interchange



## IMPACT ON REMAINDER PARCELS

The intent of the condemning authority in a right-of-way acquisition is that the property owner receive fair compensation for the property taken as well as for any damages incurred by the residual. Many state highway departments felt that the damages being paid were too much and undertook investigations concerned with what happens to individual residual tracts. Indiana's initial studies in this area were conducted by the Joint Highway Research Project as a part of this Study.

It was intended that the investigations be indicative for the entire state of Indiana, as well as a documentation of the case histories of remainder parcels. In order to insure that the results would be representative, all projects placed under construction contract between the 1st of January 1955 and the 31st of December 1961 were divided into two groups, namely, interstate or primary and secondary route projects. A sample of 31 was then drawn at random from the 99 interstate projects and another sample of 35 from the 430 projects on primary and secondary routes. Figure 2 shows the geographical distribution of the sample projects.

A check was then made of county records to determine which remainder parcels had been sold following the right-of-way acquisition. Data concerning the land use, zoning, distance to nearest trading center, etc. were obtained and the sale price was verified by interview with the grantee and/or grantor. Information as to the "before" value as appraised, amount of settlement, area taken, etc. was obtained from the files of the Division of Land Acquisition.

Of the 2,300 individual remainder parcels that were investigated, only 46 resulted in case studies. Of these, 16 were on primary or secondary routes and 30 were on interstate routes. The following example will indicate the basic nature of these case studies. The "before" values indicated are the average of two fee appraisals made for the highway commission.

The main portion of the farm shown in Figure 3 was severed into two tracts by the construction of an interstate highway - Tract II on which the improvements were located and Tract III which was left landlocked and which was subsequently sold. The average appraised "before" value of this landlocked tract and the damages paid are summarized below:

"Before" value of Tract III	16,700
Damages paid due to landlocking	14,600
Apparent "After" value	2,100



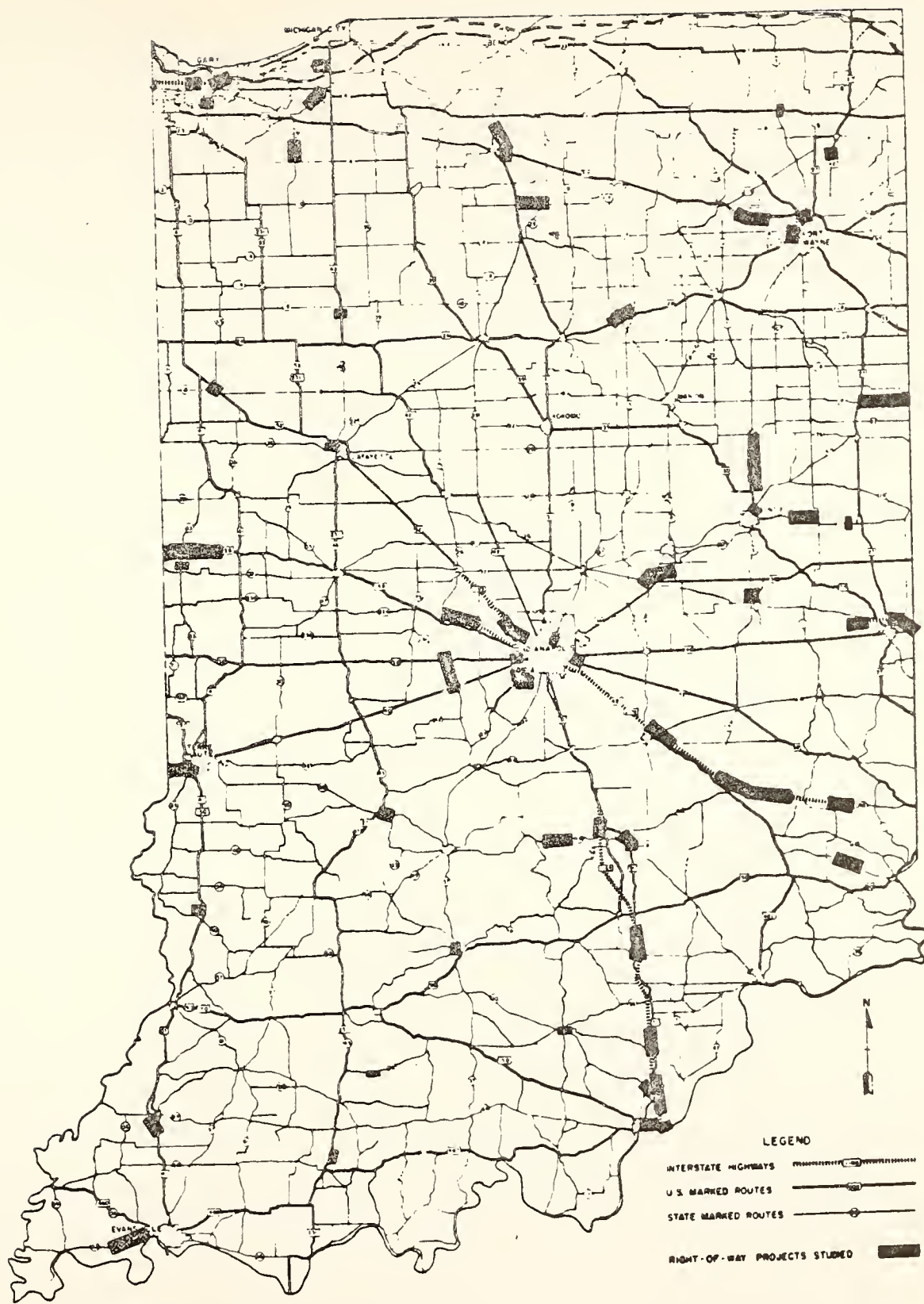


Figure 2. Location of Right-of-Way Projects in Sample.



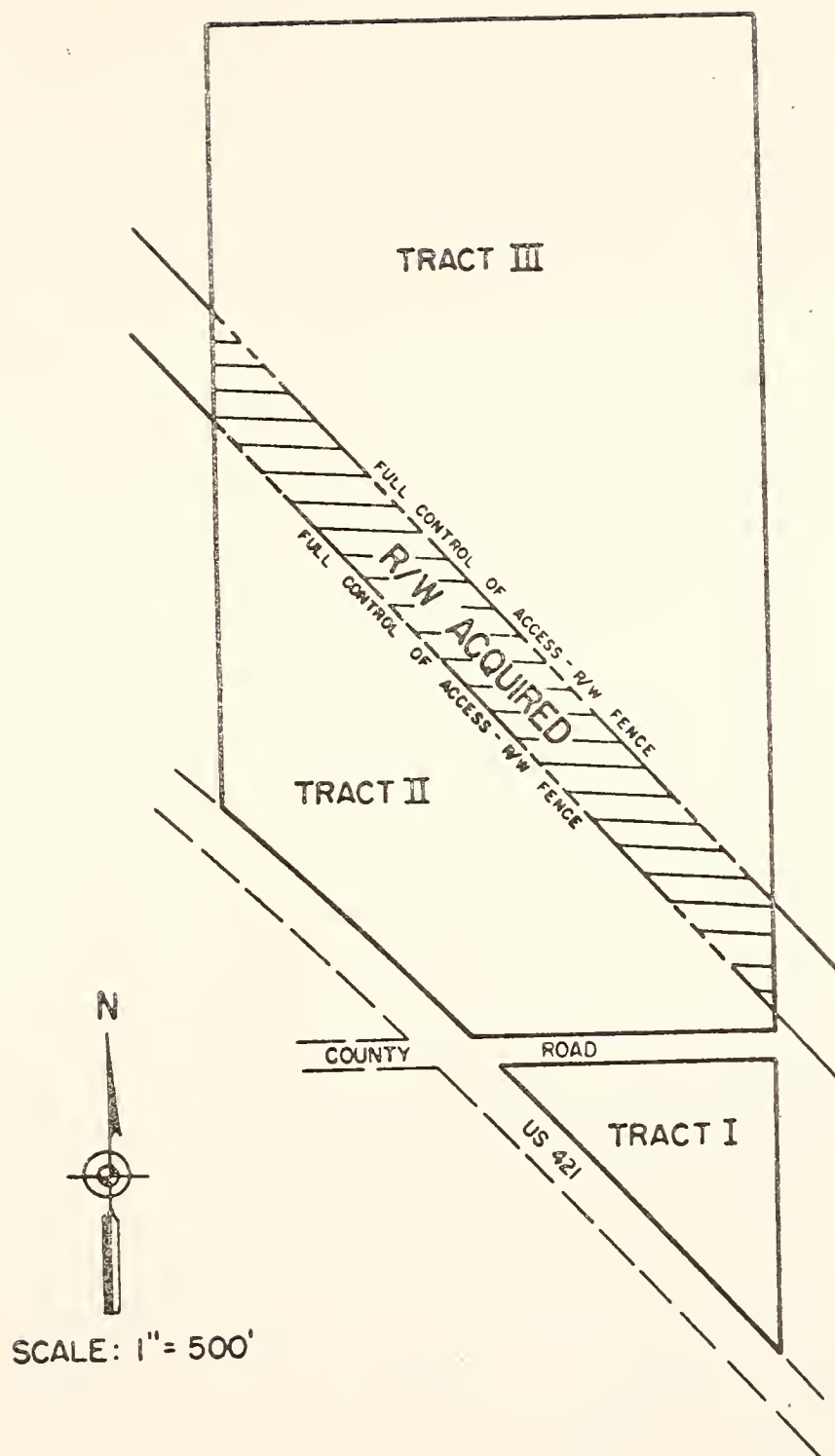


Figure 3. Case Study Example Property.







Between the time when the settlement was made and the date of the subsequent sale, the general price level of local farm acreage increased by about 10 percent. This would be about \$200 for the parcel in question. Therefore, the "after" value of Tract III at the time of sale would presumably have been \$2,300. The tract actually sold to one of the adjacent owners for \$17,500.

Applying the 10 percent increase in local land value to the appraised "before" value indicates that the 49 acres would have been worth about \$18,400 at the time of sale if no damages had been involved. The sale price was only \$900 less than this figure, the real damage sustained, while \$14,600 was the price paid in damages.

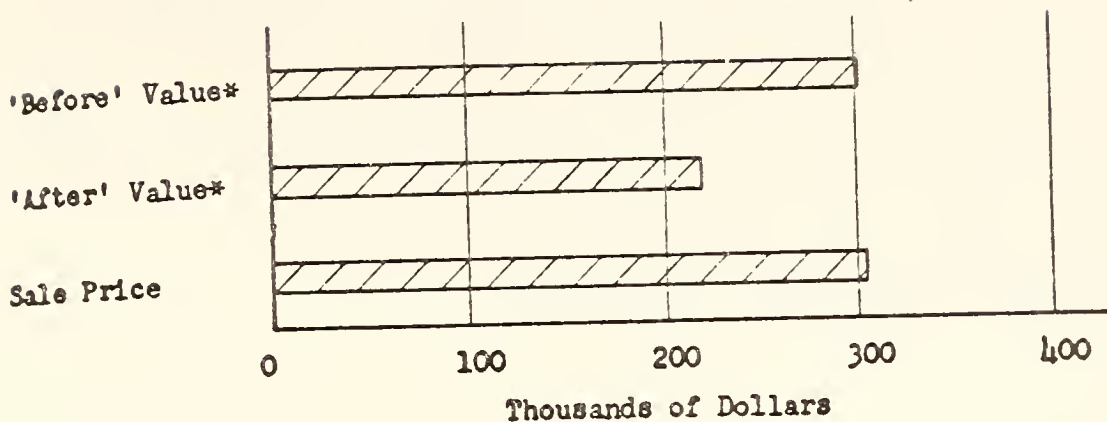
Conclusions were made from summaries of the data obtained from the 46 case studies. Figure 4 shows a comparison of the totals for the "before" values, the apparent "after" values, and the sale prices of the remainders which were created by a right-of-way taking for either an interstate or a primary or secondary route. The Figure shows that the total of the sale prices for the primary or secondary route cases exceeded not only the "after" values but also the total of the "before" values. Yet, over 25 percent of the total of the "before" values was paid for the parts taken and for damages to the residual. The data also shows that for the interstate route cases the total of the sale prices exceeded the total of the apparent "after" values by about 20 percent. However in contrast to the data for the primary and secondary routes, this total was considerably less than the total of the "before" values.

A comparison of the damages paid with those sustained was made to determine the magnitude of excessive damages paid. For the 16 cases involved on the primary and secondary routes, the total damages paid exceeded those sustained by about 15 percent. Damages paid in the 30 cases involved in an interstate taking exceeded the damages sustained by nearly 30 percent. But totals do not show whether all owners are compensated equally and further breakdowns were necessary.

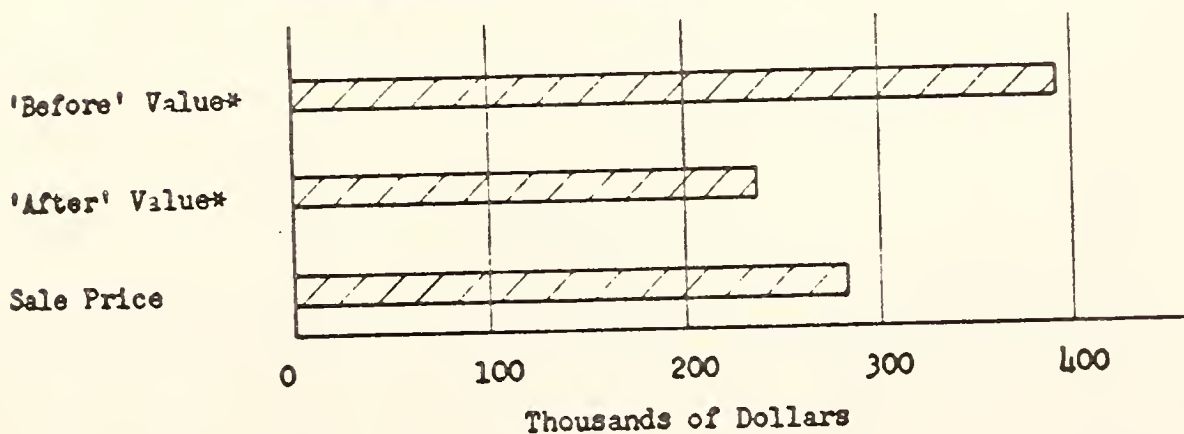
Figure 5 shows a graphical representation of the frequency with which damages paid were more than, equal to, or less than damages sustained. As indicated, in 20 percent of the primary route cases the damages paid were significantly less than those sustained. Also, in 40 percent of the interstate cases the residual sustained significant uncompensated damages. Thus in certain types of situations, damages were consistently over or under paid. Analysis indicated that landlocked and separated tracts were two situations where a general overpayment of damages occurred.



### Primary and Secondary Routes (16 Case Studies)



### Interstate Routes (30 Case Studies)



\* Individual values have been adjusted for any change in local real estate price level that occurred between the time of the appraisal and the date of sale.

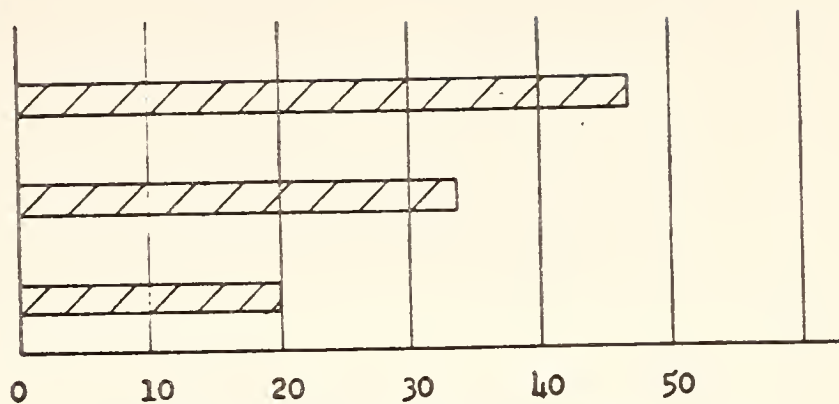
Figure 4. Comparison of Totals for 'Before' Value, 'After' Value, and Sale Prices in Constant Dollars.



### Primary and Secondary Routes

Damages Paid Were

- More Than Sustained
- Equal to Sustained
- Less Than Sustained

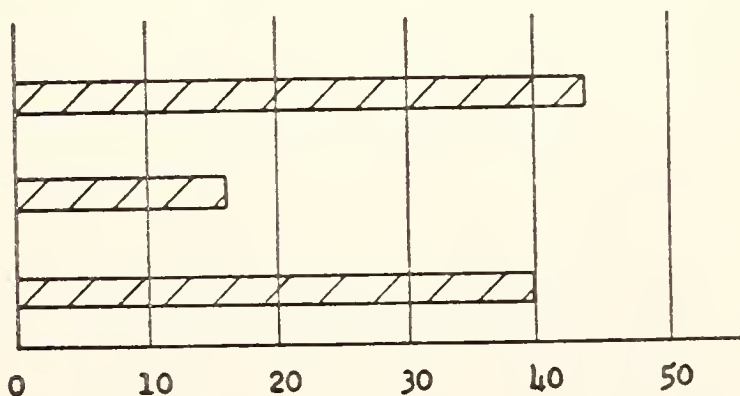


Frequency as a Percentage of Remainder  
Parcels Involving Damages

### Interstate Routes

Damages Paid Were

- More Than Sustained
- Equal to Sustained
- Less Than Sustained



Frequency as a Percentage of Remainder  
Parcels Involving Damages

Figure 5. Frequency with Which the Damages Paid Equaled the Damages Sustained.



As shown in Figure 6, the damages paid for landlocking, no access by road possible, were found to be two and one-half times the damages paid. On the average, only 34 percent damages were sustained by the several landlocked tracts while 80 percent damages had been paid.

Similar data for tracts which were separated from the main portion of the residual, but not landlocked, are summarized in Figure 7. These data show that the total damages paid were over three and one-half times those sustained. These tracts sustained an average of less than 10 percent in damages compared to over 30 percent paid.

Major conclusions drawn from this study were:

1. There were very significant enhancements to some residuals; however, the frequency of these occurrences was relatively small; about 10 percent of the cases showed a very significant enhancement.
2. Although there was a general overpayment of damages a sizable portion of the residuals suffered significant uncompensated damages; 20 percent of the case studies on primary and secondary routes and 40 percent of the case studies on interstate routes had uncompensated damages.
3. Damages paid for landlocking and separation of property were considerably more than the damages sustained.

The case studies developed in this Study were also submitted to the Bureau of Public Roads Severance Effects Bank and along with those from other states were used by the Bureau in developing much information on benefits and damages resulting from taking of right-of-way for highway improvements. Following completion of the initial studies by JHRP under the Study in 1963, the Indiana State Highway Commission continued collection of information in its Land Acquisition Division on remainder parcels as a routine procedure and in effect continued the research begun in this portion of the Study.





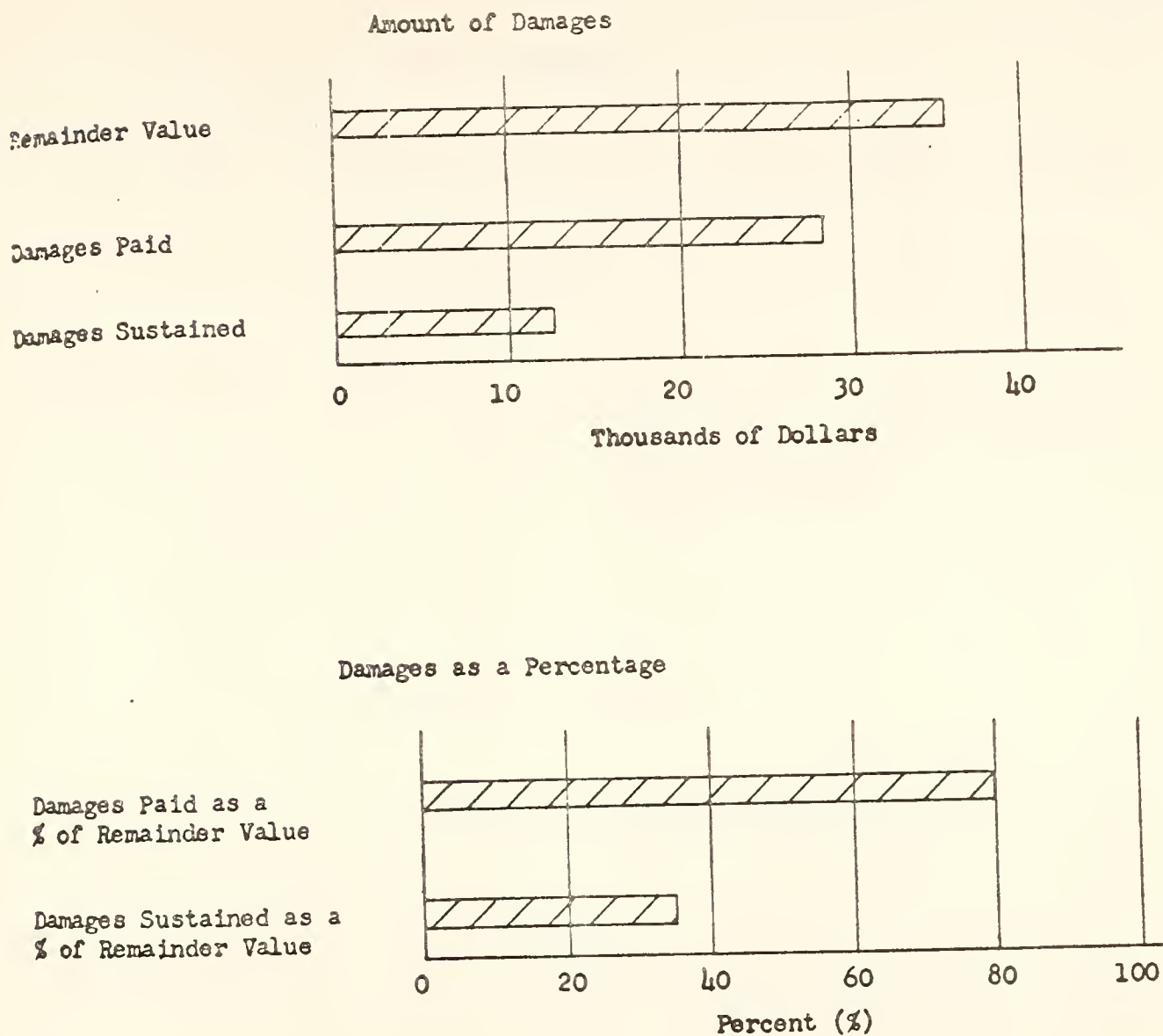


Figure 6. Summary of Damages Paid and Sustained by Landlocked Tracts.



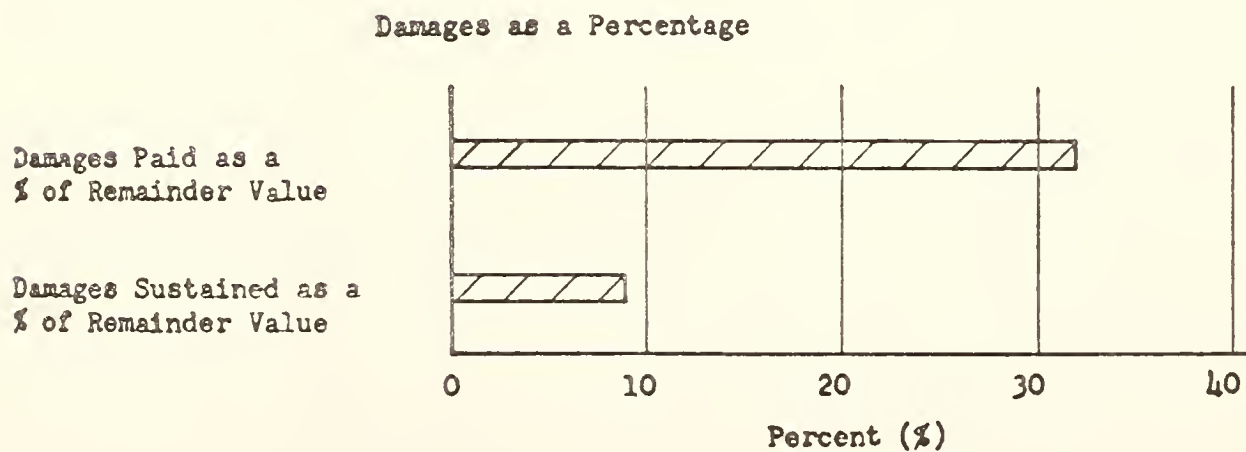
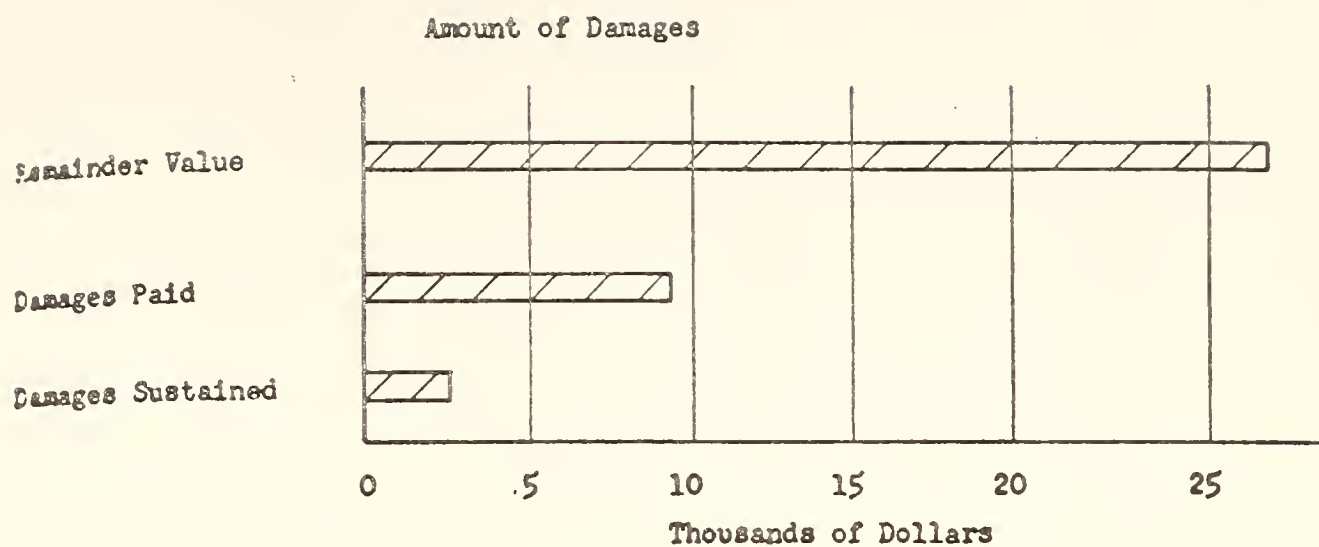


Figure 7. Summary of Damages Paid and Sustained by Separated Tracts.



## EARLY IMPACT OF A RURAL HIGHWAY WITH COMPLETE ACCESS CONTROL

The immediate effects of an interstate are of importance to the people living in the adjacent and neighboring areas and also as information to the planner for more efficient, economical, and beneficial highway location in the future. For this reason a study was done in 1961 of the early effects of Interstate 65 from the south end of the by-pass around Lebanon southeastwardly to the north approaches of the Interstate 465 interchange around Indianapolis. The study was concerned with costs and possible changes in traffic patterns, land values, land use, travel time, and accidents.

Interstate 65 replaced U.S. 52 and was built according to interstate standards. The length of U.S. 52 within the study area is 13.655 miles while the interstate is 13.081. The area under study is predominately agricultural and because of this the cost per mile of building the interstate was only approximately \$700,000.

Traffic volumes and travel times were measured on the two roadways. While the volumes on the interstate were low, they were expected to increase when the entire interstate would be completed to Chicago. The travel time for the Interstate 65 study segment was 3 minutes and 32.3 seconds less than for the U.S. 52 equivalent segment. This meant a total time savings for passenger vehicles using Interstate 65 instead of the adjacent U.S. 52 of 900 hours daily. Using the AASHO value of time cost of \$1.55 per hour, time saving and operating cost benefits to passenger car users only were estimated to be slightly more than \$1,000,000 per mile over a design life of 20 years of this section of Interstate 65.

One of the major benefits claimed for a controlled access facility is accident reduction. This study was performed only one year after the opening of this section of Interstate 65 and the results were not considered conclusive. A reduction in the frequency of accidents, however, was observed.

Of the numerous crossroads with at-grade intersections along the length of U.S. 52 included in the study area, seven intersecting roads had been closed. Interchanges or overpasses were provided for the remaining seven roads. The relative close spacing of the interchanges and overpasses and the building of frontage roads, however, had minimized disruption of local traffic patterns, except for a few farmers who farmed on both sides of Interstate 65 and were not adjacent to a crossover facility.



Almost all of the land in the study area was agricultural when construction of Interstate 65 began and there were few changes prior to the study period. Although there were very few sales of property available for study, there appeared to be little change in land value.

A study was conducted of the right-of-way acquisitions for this roadway. Again only a very few of the sixty-two separate parcels had been sold to make comparisons of actual damages sustained. But the actions of the courts in awards of damages is important.

Thirty-two of the parcels, or slightly over fifty percent, required court condemnation proceedings. In all but two cases the court awards were higher than the state appraisal of land and damages. As shown in Table 1, the court appraisals of damages to the condemned parcels were almost one hundred percent greater than the state appraisals. Figure 8 graphically shows this difference and especially the difference in severance damages. The court appraisal figures for severance damages were more than three hundred percent of the state appraisal figures.





Table 1. Summary of Appraisal Figures.

Appraisal	Land	Improvements	Severance	Other	Total
State	\$138272	\$133789	\$ 86741	\$26627	\$385429
Court	199044	159194	299217	83293	740748

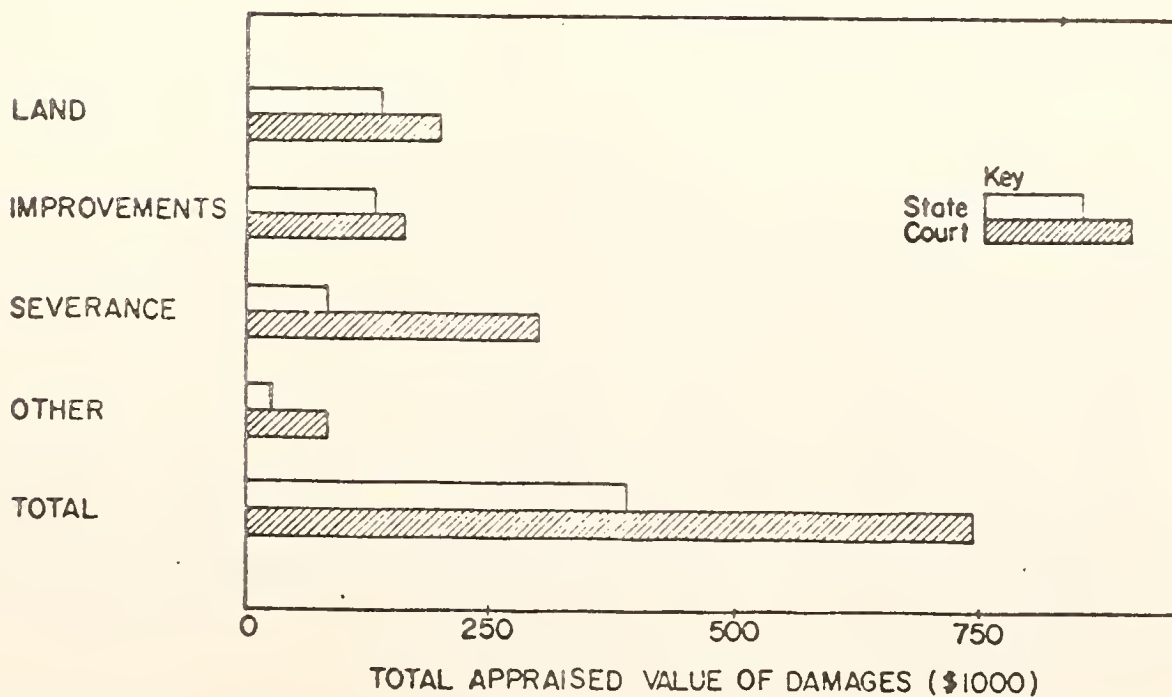


Figure 8. Total Appraisals for Right-of-Way Costs.



## IMPACT OF SMALL CITY BY-PASSES

The tremendous increase in population and vehicle registration within the United States in recent years has created traffic snarls which are threatening to strangle many urban areas. An attempt to alleviate this congestion problem in the central portion of small to medium sized cities frequently has included the construction of bypass routes which skirt the periphery of a city.

In this Study, an urban by-pass with complete control of access and an urban by-pass with little or no control of access were analyzed. The analysis included traffic volumes, travel times, accidents, land use, land value and right-of-way. The primary purpose was to develop information which could be used when planning other bypass facilities.

Kokomo, Indiana was faced with a congestion problem due to U.S. 31, and in 1950 a bypass facility with little or no control of access was opened to traffic. Initially the volumes only warranted building two lanes but right-of-way was obtained for an additional two lanes and a 40 foot median strip. The by-pass increased the travel distance on U.S. 31 from 6.835 miles to 7.250 miles, but the travel time in 1951 was decreased from 14 minutes and 3 seconds to 8 minutes and 43 seconds.

Considerable development occurred along the Kokomo By-Pass from 1950 through 1958 and additional traffic volumes were generated. By 1958 the traffic volumes warranted the addition of the final two lanes, except for a short section at the north end of the by-pass. On June 16, 1960, the additional two lanes were opened to traffic.

At the time that this study was made, 1964, a traffic volume count was made and is shown pictorially in Figure 9. As can be seen there are large volumes not only on the by-pass but also on the intersecting streets. With the large volumes had come traffic signals at several intersections, congestion, increases in travel time, and an increase in accidents. All of which reduced the operational efficiency of the by-pass. Because of increases in traffic volumes and a rapid growth of establishments adjacent to the by-pass, lower speed limits had necessarily been posted. It was feared at the time of this study that in the future the by-pass would lose its usefulness and become a major bottleneck.



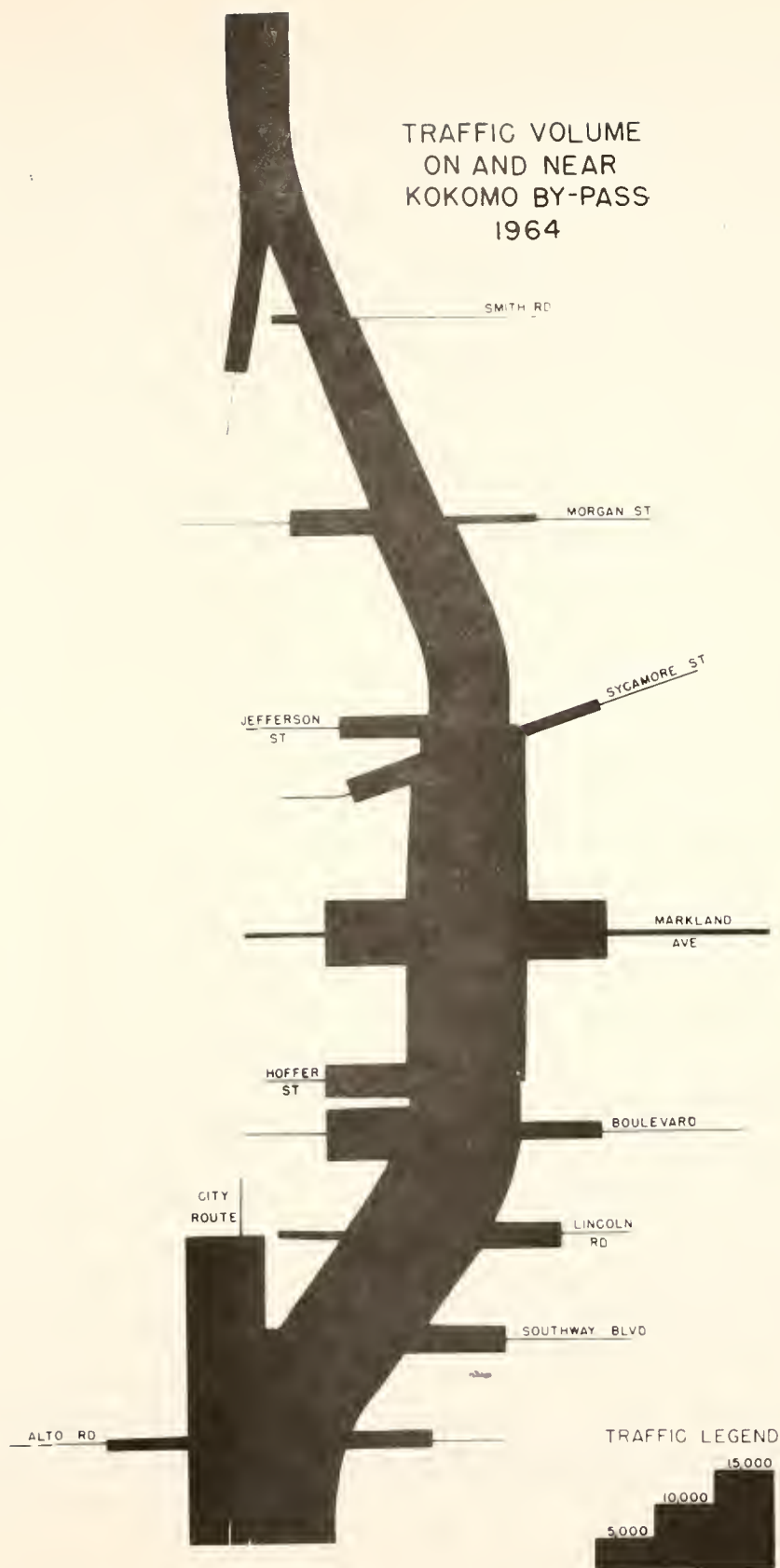


Figure 9. Traffic Volume On and Near Kokomo Bypass 1964.



Travel time and overall average speed for the city route and the by-pass were also calculated in 1964. Speeds were 47.4 miles per hour on the by-pass and 25.7 miles per hour on the city route. A savings of 6 minutes and 45 seconds was still realized by traveling via the bypass. It was observed that there were two seemingly incompatible groups that used the by-pass. It was observed that these groups were local and non-local drivers. An analysis showed that there was a significant difference in speeds driven by the two groups of drivers with the local drivers traveling at a significantly lower rate of speed. These incompatible uses are believed to be a primary contributor to vehicular accidents and delay on this highway.

For an economic analysis the present Kokomo By-Pass was compared with a fictitious Kokomo By-Pass with full control. In the summer of 1964 the average speed in Indiana of free flowing passenger cars on four-lane divided facilities with full control of access was found to be 67.7 mph. Assuming that vehicles traveling on the Kokomo By-Pass in 1964 would have traveled in the same volume on a fully controlled access facility and at 67.7 mph had the facility been of the freeway type, a net savings of approximately \$270,000 would have been realized by motorists in 1964. This figure is based solely on time lost by the motorist traveling the by-pass at values suggested by the American Association of State Highway Officials. It does not include such losses as increased stopping costs, operating costs, idling costs, starting costs, etc.

An accident analysis was conducted for the years 1961-1963. As can be seen in Figure 10, most of the accidents occurred at the intersections. The accidents were then classified by type as follows:

- Type I - Intersection accidents which occur at the crossing of two traffic streams. These accidents are typically right-angle, turning, and rear-end collisions.
- Type II- Marginal accidents which occur along the moving edge of a traffic stream. These accidents result from vehicles attempting to enter or leave the traffic stream. Typical accidents are rear-end and access collisions.
- Type III-Medial accidents which occur between vehicles moving in opposite directions. Head-on collisions and side-swipes are typical accidents of this type.





ACCIDENTS	
PROPERTY DAMAGE	- 204
PERSONAL INJURY	- 94
FATAL	- 1
	<hr/> 299

#### ACCIDENT LEGEND

- PROPERTY DAMAGE
- PERSONAL INJURY
- ⊗ FATAL

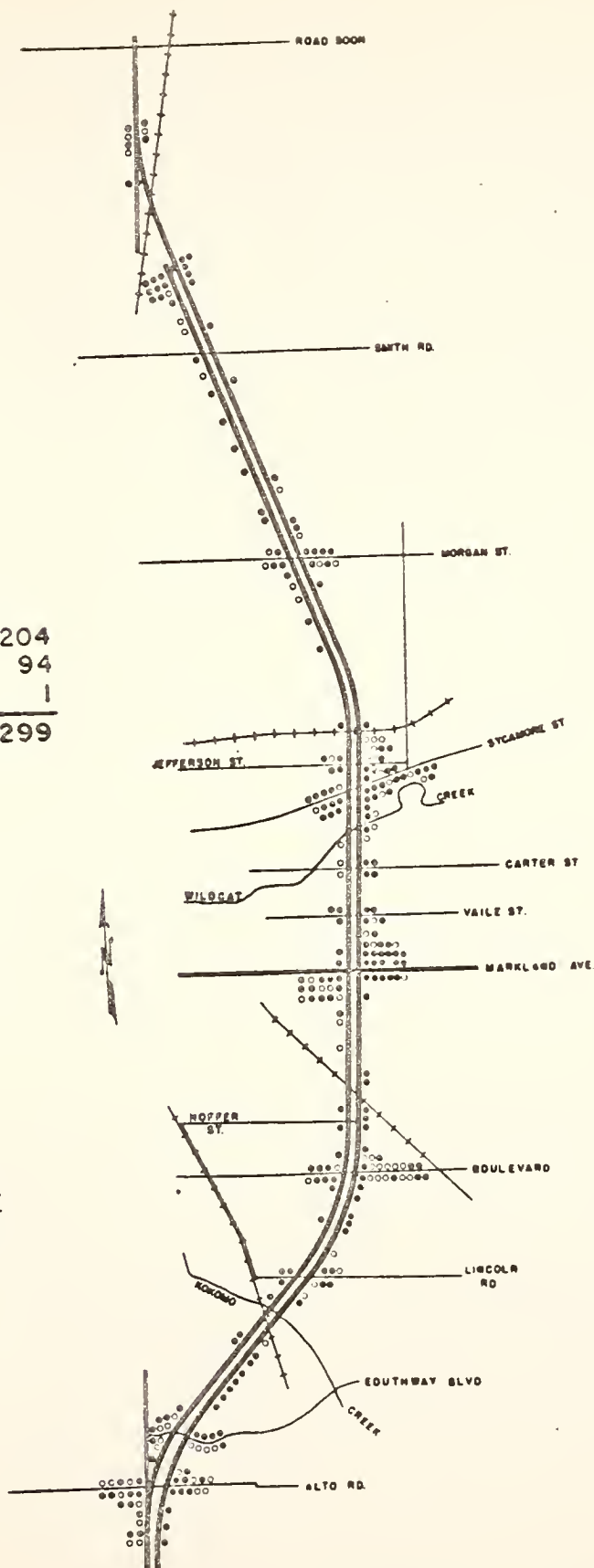


Figure 10. Accident Spot Map for Kokomo Bypass for 1961, 1962 and 1963.



Type IV - Interstream accidents which occur among vehicles moving in the same direction. These include such miscellaneous accidents as running off the road, overturning, and some rear-end collisions. This type of accident will occur on any facility.

Figure 11 illustrates the accident trends by type from 1957 through 1964. The most pronounced increase was in the Type I accident. Because Types I and II accidents are virtually eliminated on a controlled access facility with grade separations, an economic analysis was conducted to determine the loss to the motorist because the facility was not of the controlled access type. It was found that there was a loss of \$469,000, which might have been wisely spent in 1950 for the purchase and construction of full access control.

With the variety of development that occurs along a new facility it is frequently difficult to determine which developments are a result of the new route and which would have been present had the facility not been constructed. Reasons for establishing along the Kokomo Bypass, however, seemed to be clearly defined. Most of the commercial and industrial developments in the vicinity of the bypass either served the motoring public or were dependent on the accessibility provided by the bypass.

Land use patterns for 1948 and 1964 more clearly portray the land use changes within one mile of the bypass (see Figure 12 and 13). Prior to the construction of the bypass the area was predominately agricultural. During and after the construction of the Kokomo Bypass, businessmen began exploiting the economic possibilities which the bypass was certain to provide. And today the area adjacent to the bypass includes industrial, commercial, and residential establishments.

The effect that a bypass has on the land values within the area is a question often asked. Land values within one mile of the bypass increased at a faster rate than land values in any other portion of the Kokomo area. Also land values on the side toward the city center were higher. Figure 14 shows these results. Land values along the city route (old U.S. 31) increased slowly following the construction of the Kokomo Bypass. But after 1956, land values in the vicinity of the old city route substantially increased. It was therefore concluded that for the long term, the bypass did not have a detrimental effect on property values along the old city route.



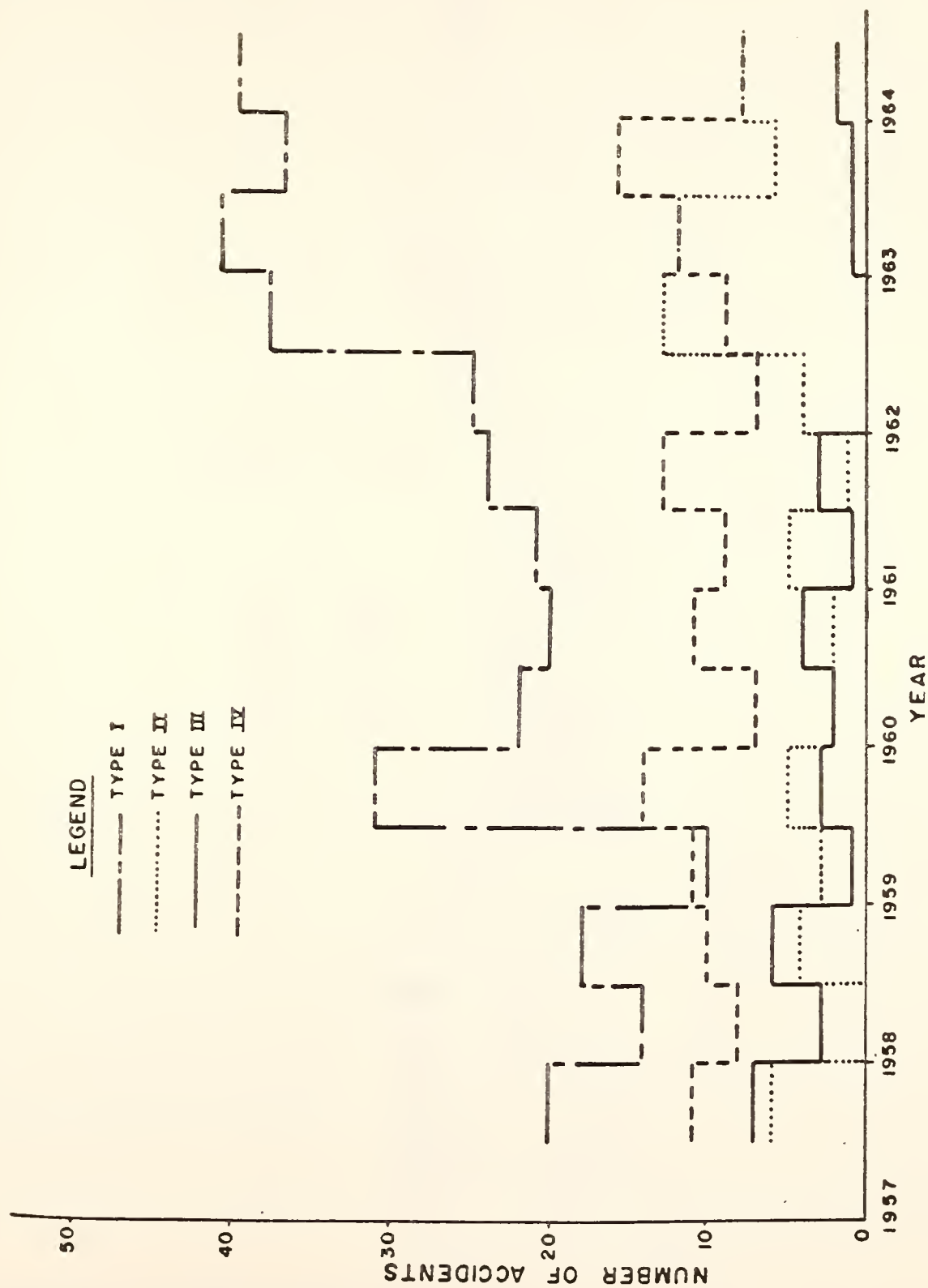


Figure 11. Number of Accidents by Type and Year.



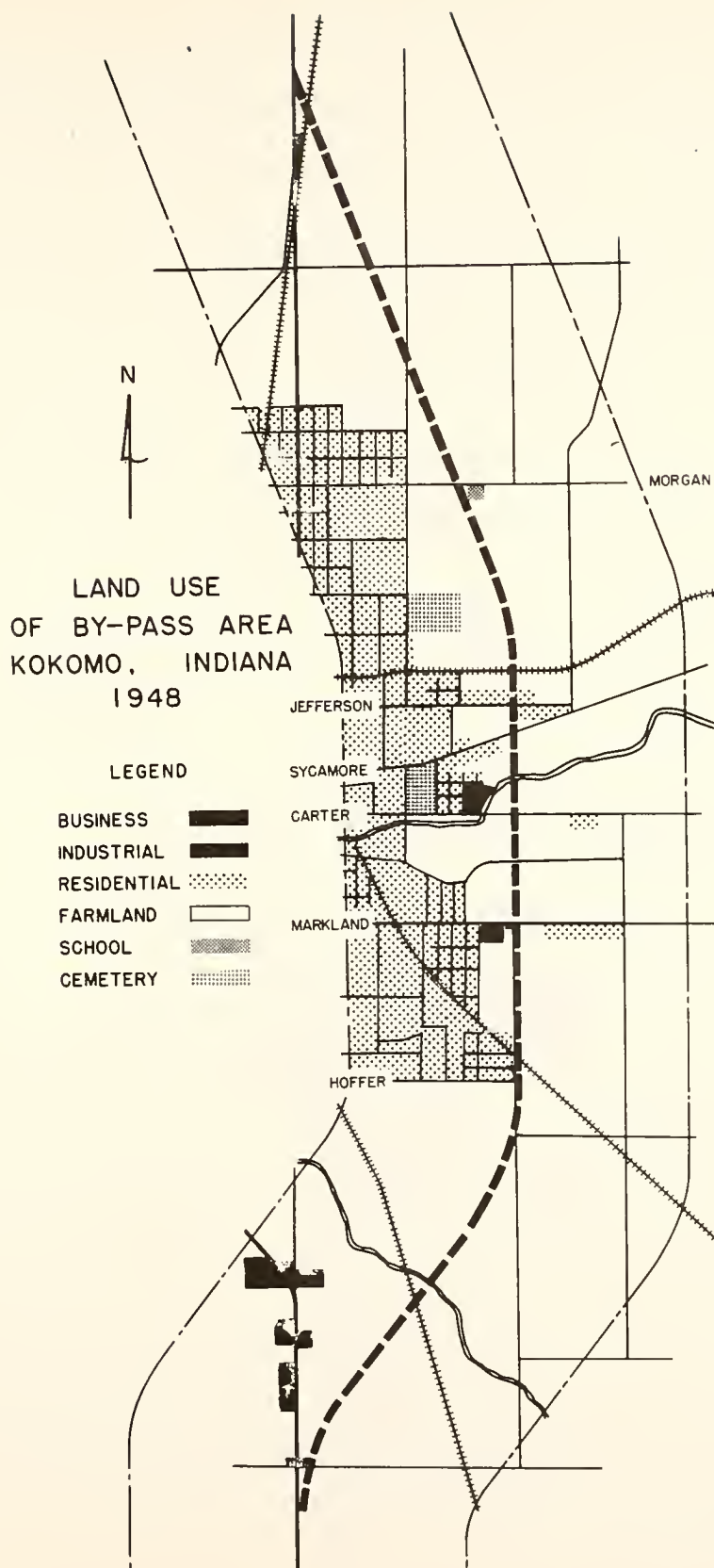


Figure 12. Land Use of Bypass Area, Kokomo, Indiana, 1948.





LAND USE  
OF BY-PASS AREA  
KOKOMO, INDIANA  
1964

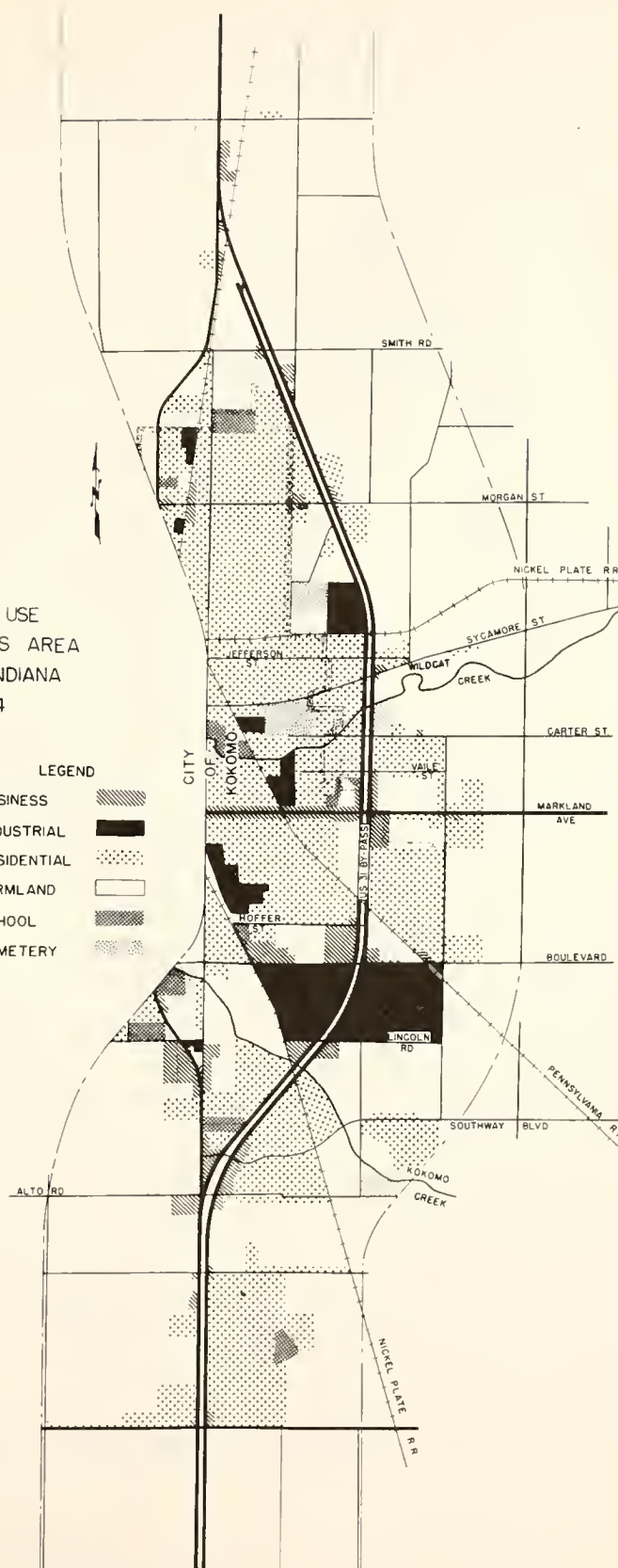


Figure 13. Land Use of Bypass Area, Kokomo, Indiana, 1964.



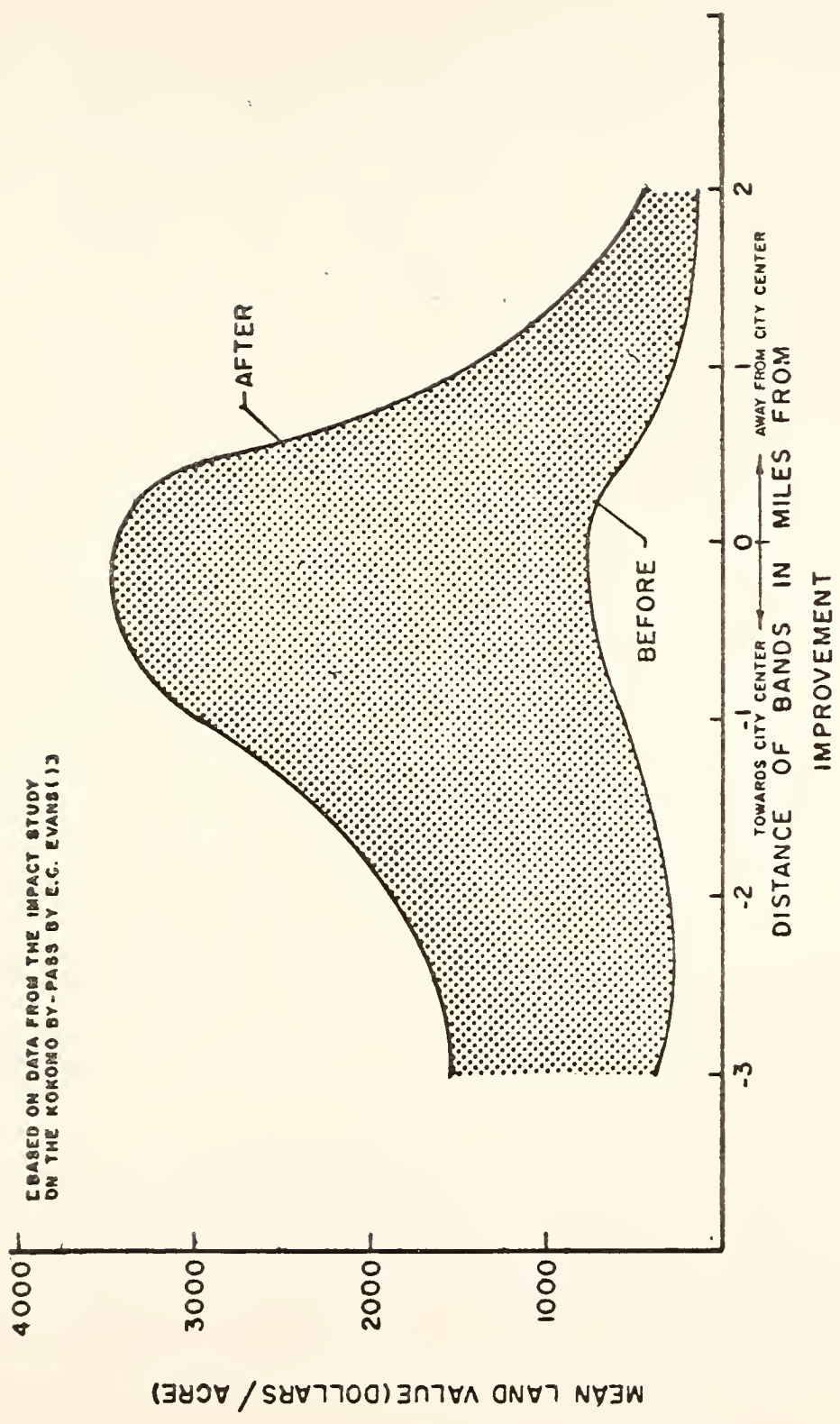


Figure 14. Mean Land Value in Constant Dollars at Various Distances from the Improvement.



A study of nine properties which were partially taken for the right-of-way for the Kokomo Bypass revealed that the remainder parcels were usually enhanced in value. This study showed that the greatest enhancement of land occurred when it changed from one use to another. A further finding was that land value enhancement continued for many years following the completion of the highway improvement.

In summary this bypass, with little control, increased land value and caused the growth of the city toward it. But because of little control there is increasing congestion of traffic flow on it and increased accidents.

Lebanon, Indiana was faced with a similar problem as Kokomo in 1950. A bypass for U.S. 52 was determined necessary and sufficient right-of-way was acquired for a non-limited access four-lane divided highway. However, traffic volumes at the time of construction were such as to warrant completion of only two lanes.

In 1957 a study was conducted to evaluate the operational efficiency of the bypass and to determine the long range economic effect of the facility on the city of Lebanon. The study indicated that the travel time savings had been reduced from slightly over four minutes to three minutes. This was due mainly to the fact that traffic signals had to be installed at two intersections. Traffic volumes were also by 1957 heavy enough to warrant the bypass to be a four lane facility. Accident records showed that there were a high number of accidents at the two main intersections of U.S. 52 bypass with State Route 32 and State Route 39.

However, when land use changes due to the bypass were checked there seemed to be little effect. One of the major reasons for this was that an elevated railroad right-of-way separates the city from much of the bypass and apparently influenced the effect of the bypass on land use.

It was decided to reconstruct the original U.S. 52 Bypass to Interstate standards as a portion of Interstate 65. This required an additional 75 acres of right-of-way. Since there had been a few improvements made adjacent to the original bypass, this land acquisition was very costly. If this same right-of-way had been purchased in 1947 when the initial right-of-way was purchased the state would have saved \$543,000.



Upon completion of the bypass to interstate standards, the overall pattern of land use to 1960 in the Lebanon area was only slightly altered. By comparing Figure 15 with Figure 16 one can see that growth continued to be mainly to the north. The bypass acted as a mild stimulant to highway oriented commercial development, but at the same time became a natural barrier to residential land development south of the city. The railroad embankment, the Pennsylvania Railroad line, along the west edge of the city also still acted as a natural barrier to expansion in that direction.

An analysis of land values showed that there was an increase of land value only to property within one mile of the bypass. The land within one-half mile of the bypass was particularly sensitive to the construction and reconstruction of the facility. This land experienced a rapid and considerable increase in value immediately following construction of the non-limited access facility but this increase sustained a dampening affect upon reconstruction of the facility to interstate standards. This value, however, was still considerably higher than land more distant from the facility.

When the bypass was completed according to interstate standards, improvements in traffic volume, travel times, and accident rates were made. Congestion conditions were eliminated and the traffic flowed freely. During the final study year of 1963, the volumes were fairly light and traffic was able to maintain an average speed of 63 miles per hour. Travel time was slightly more than two minutes faster than the original bypass in 1957.

An accident analysis was done of the two lane bypass and the completed interstate bypass. The study showed that the average accident cost per year on the two lane highway was \$86,338, and on the four lane, limited access highway was \$24,230.

In summary the limited access highway substantially reduced accidents and travel time. Furthermore, only property located within one-half mile of the bypass was appreciably affected by the reconstruction to interstate standards and that impact was a dampening in the rate of land value increase.







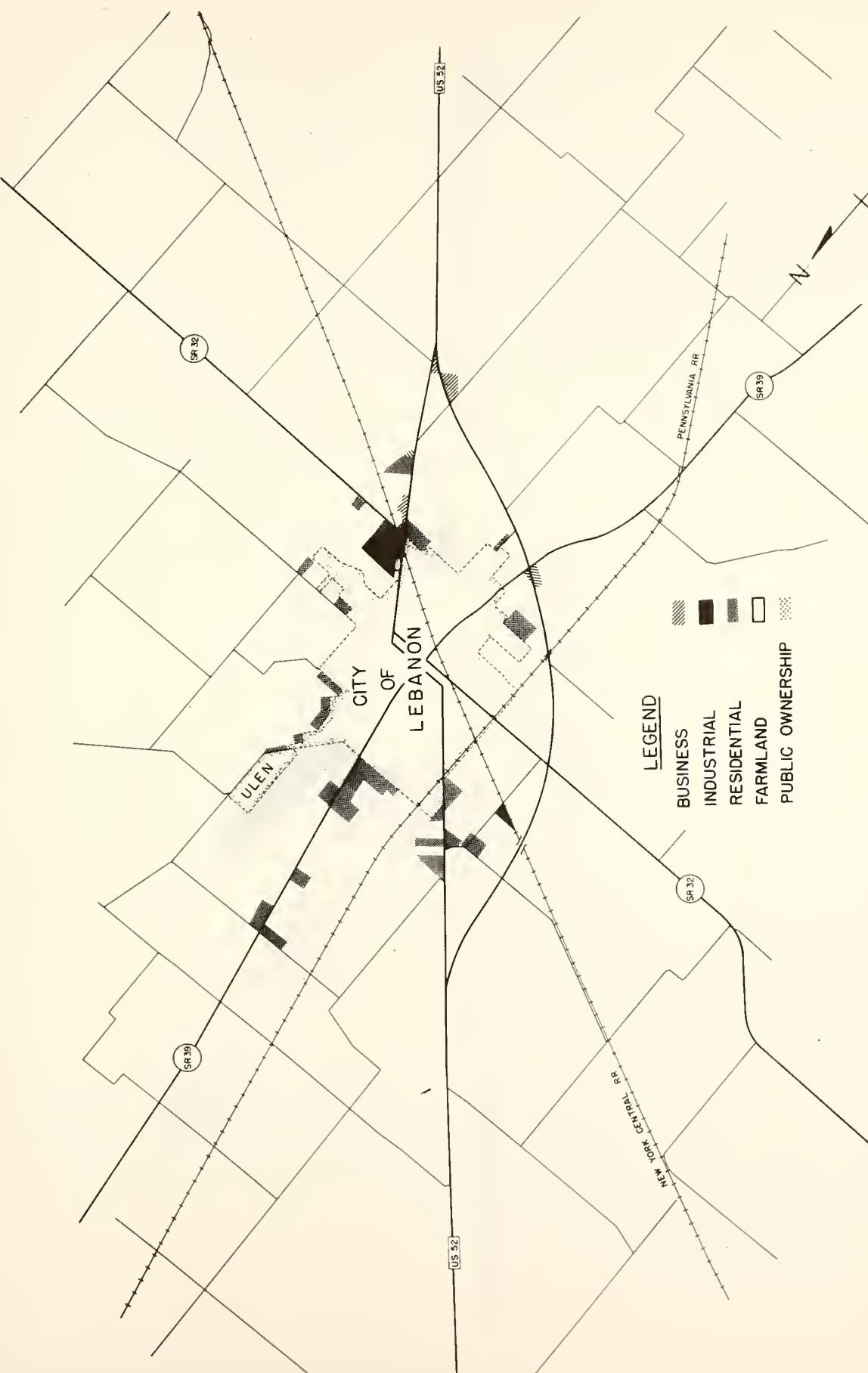


Figure 15. Lebanon Area Land Use 1950.



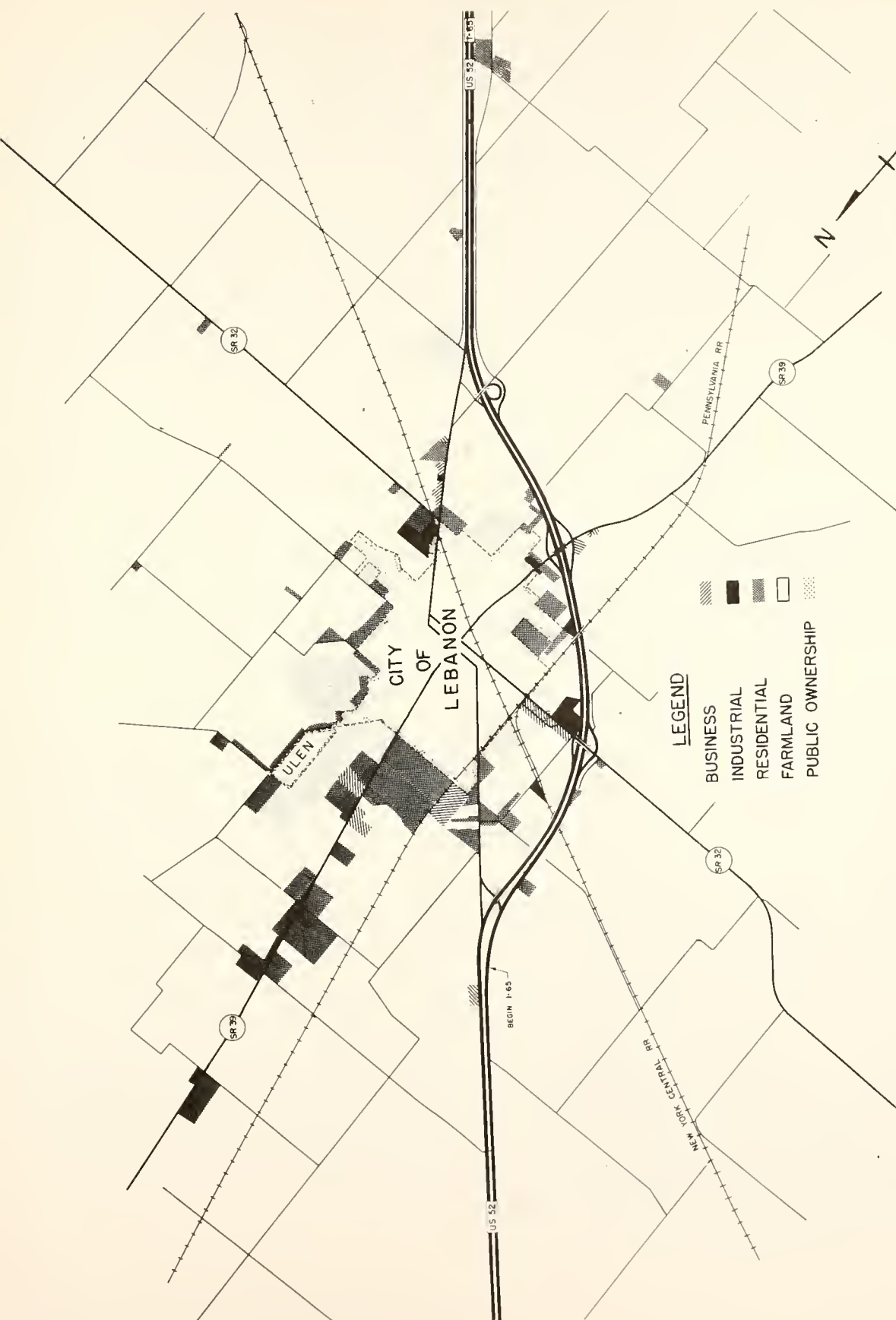


Figure 16. Lebanon Area Land Use 1960.



## IMPACT OF A NEW RIVER CROSSING IN A SMALL CITY

With increases in the population of urban areas and increases in vehicle registration per person, urban areas are faced with great transportation problems. But because of limited resources and land available, the highway engineer if he is to plan and build wisely must have information of the probable effect of a facility on the community, land use, land values, traffic patterns, and accidents. One type facility common to urban areas, a new river crossing (bridge) and its approaches, was studied. The U. S. 231 Bridge over the Wabash River connecting Lafayette and West Lafayette, Indiana was chosen because of its proximity to Purdue University and it was under construction at the time the Impact Study was started.

In 1962, a study by Alan F. Lohr determined the early effects of the bridge. This was done with before and after data. In 1968, Edward Fleischman did a study of the effects of the bridge after seven years.

Travel time studies were conducted in the vicinity of the Harrison Bridge (U. S. 231) in 1960, before the bridge opened, in 1961, one year after the bridge was in use, and in 1967. All three studies used the average car method for obtaining average travel times over appropriate routes. Eight to ten runs for each trip direction were made during the afternoon peak hour.

The data from these studies were summarized and presented in travel time contour maps for 1960, 1961 and 1967 (see Figures 17, 18 and 19). The maps are drawn with the origin of the time contours at the intersection of Northwestern Avenue, Grant Street and Fowler Avenue in West Lafayette. This intersection joins major routes connecting Lafayette and West Lafayette and thus was chosen as the origin.

As can be seen from the time contour maps of 1960 and 1961, a reduction in average travel time occurred for virtually every trip across the river. The time savings extended even to trips which did not use the new bridge. The original savings in travel time when the bridge was constructed remained in 1967 on these streets even though traffic volumes had increased. The design of the bridge and approaches proved to be adequate for at least the traffic growth in the seven year period following the opening of the bridge.

The reduction in travel time after the bridge was constructed primarily resulted because of an increase in average running speed and/or a decrease in



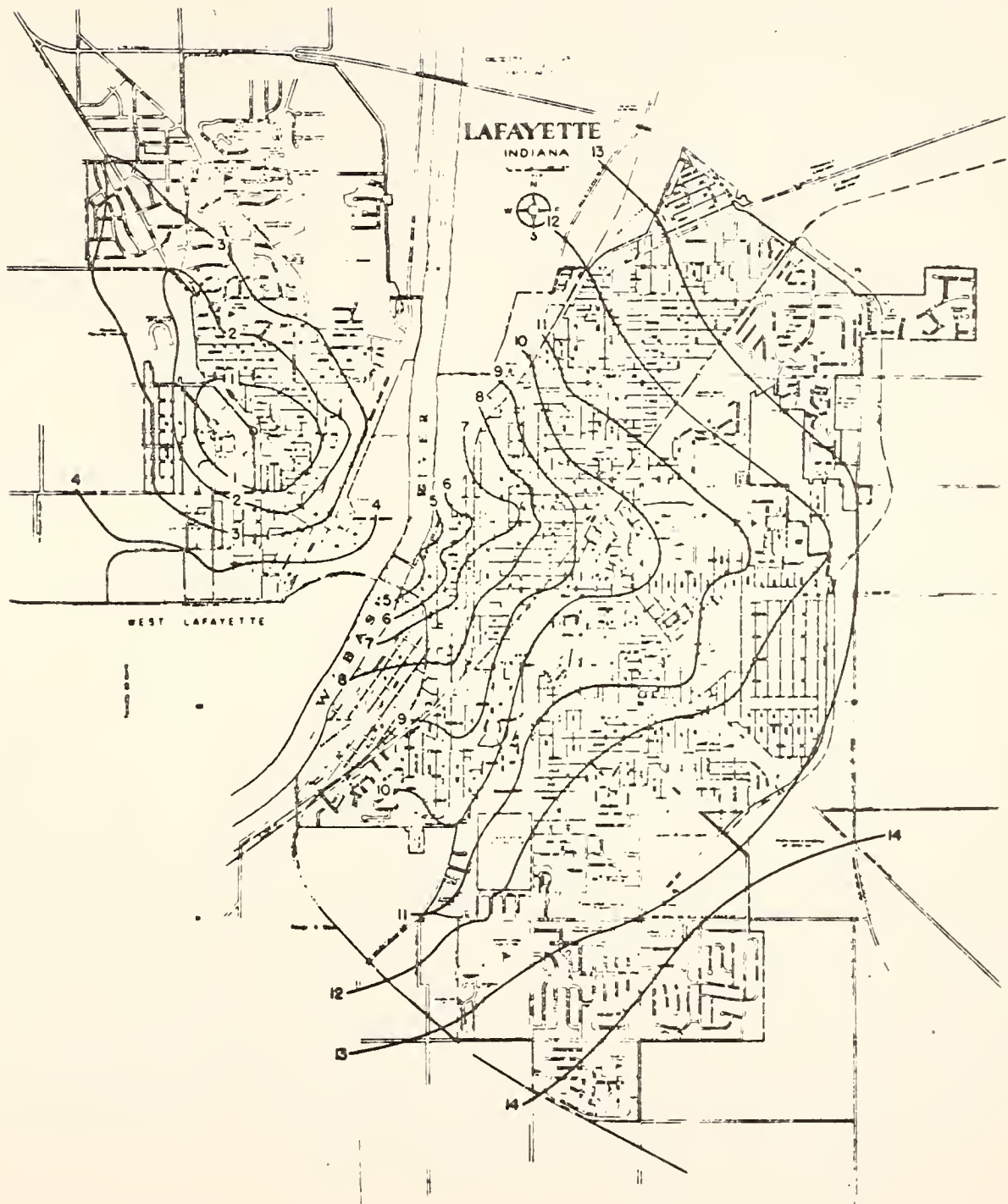


Figure 17. Travel Time Contours in Minutes for the Before Study - 1960.





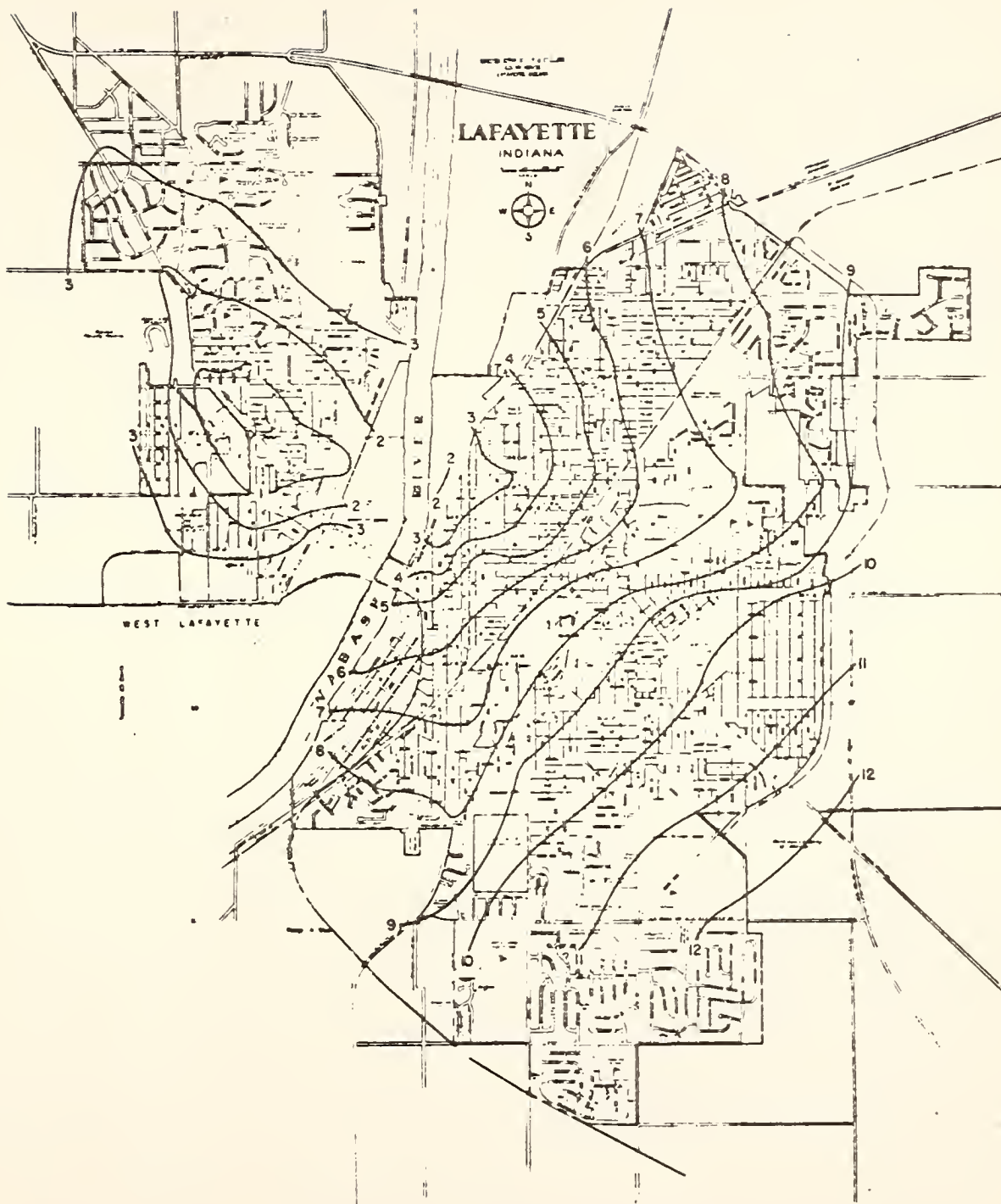


Figure 18. Travel Time Contours in Minutes for the After Study - 1961.



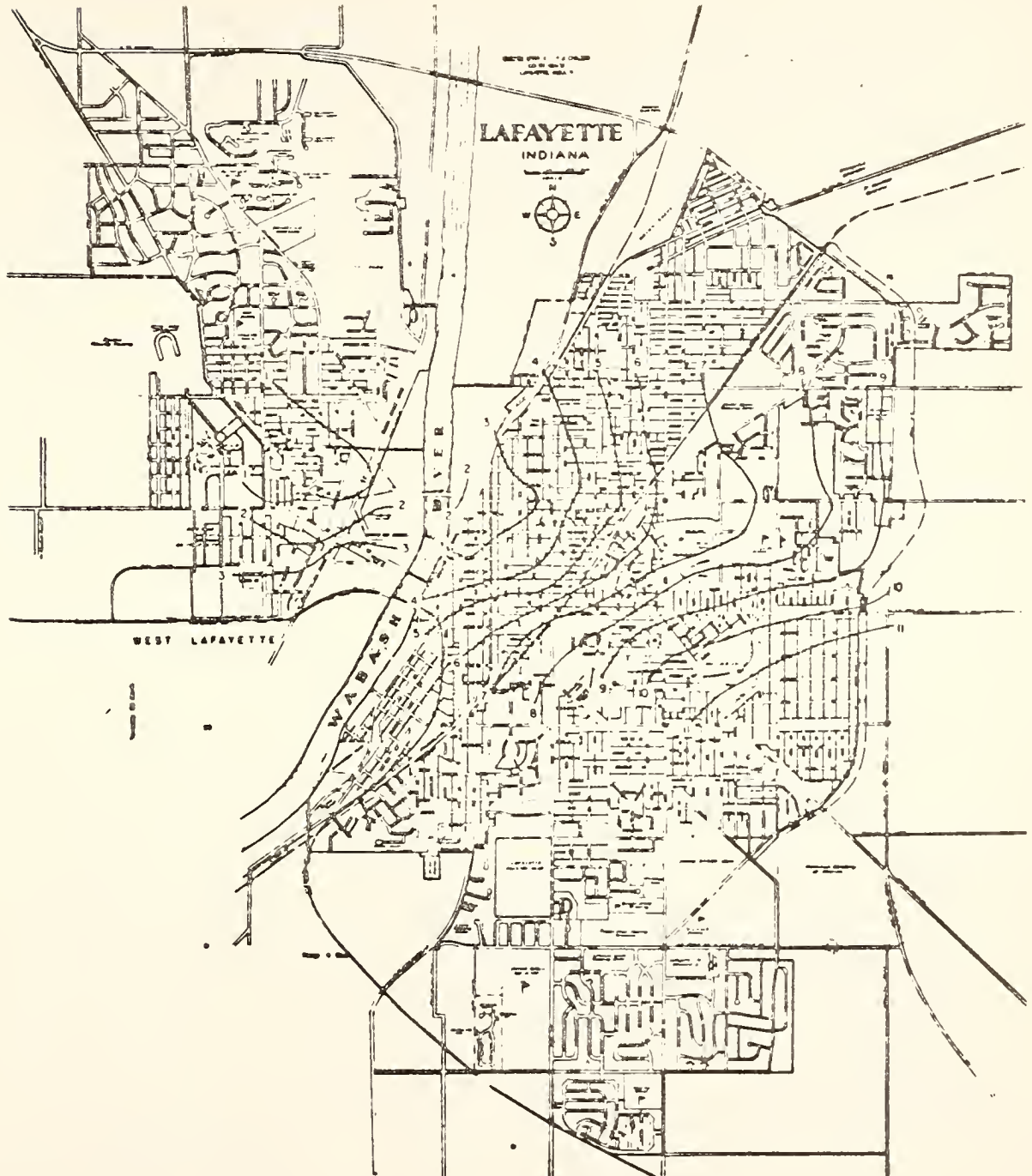


Figure 19. Travel Time Contours in Minutes for the After Study - 1967.



travel distance. Stopped time delay, primarily occurring at traffic signals, remained approximately the same during the before and after studies on routes where the distance was similar.

Traffic volume counts were made in 1960, 1961 and in 1967. The counts were taken using automatic tube type, counters. Traffic flow maps for the main artery streets are shown in Figures 20, 21 and 22. As can be seen, almost all of the streets in the Lafayette and West Lafayette area were effected by the new bridge. Much of the heavy volume on the downtown Lafayette streets in 1960 was distributed to other arterial streets leading into the new bridge.

In 1952, the Indiana State Highway Commission made a comprehensive origin-destination study which showed that 58.7 percent of the traffic crossing the Wabash River in the central area could desirably use the Harrison Bridge if it were there. But the traffic volume counts show that in 1961 only 37.9 percent and in 1967 only 40.0 percent of the total traffic crossing in the central area used the Harrison Bridge. The percentage using the Brown Street Bridge remained fairly constant from 1961 to 1967, while that on the Main Street Bridge decreased slightly.

An accident study was made of the ten year period from 1957 to 1966. In the analysis of the data, yearly means were calculated for the three-year periods 1957 to 1959, 1961 to 1963 and 1964 to 1966. Accidents for the year 1960 were not included because this was the year the bridge opened and a number of accidents occurred due to the changes in the traffic patterns.

The study showed a large increase in the number of accidents on the new arterial streets that were local streets before the bridge was opened. Most other streets in Lafayette showed a steady rise in accidents caused by a steady rise in traffic volumes and therefore in the vehicle miles traveled. But in West Lafayette, Northwestern Avenue and Brown Street showed decreases in accident rates for 1961 to 1963.

Accident rates for the arterials in the central area of Greater Lafayette for the three periods were:

1957 to 1959	11.4 accidents per million vehicle miles.
1961 to 1963	12.6 accidents per million vehicle miles.
1964 to 1967	16.6 accidents per million vehicle miles.





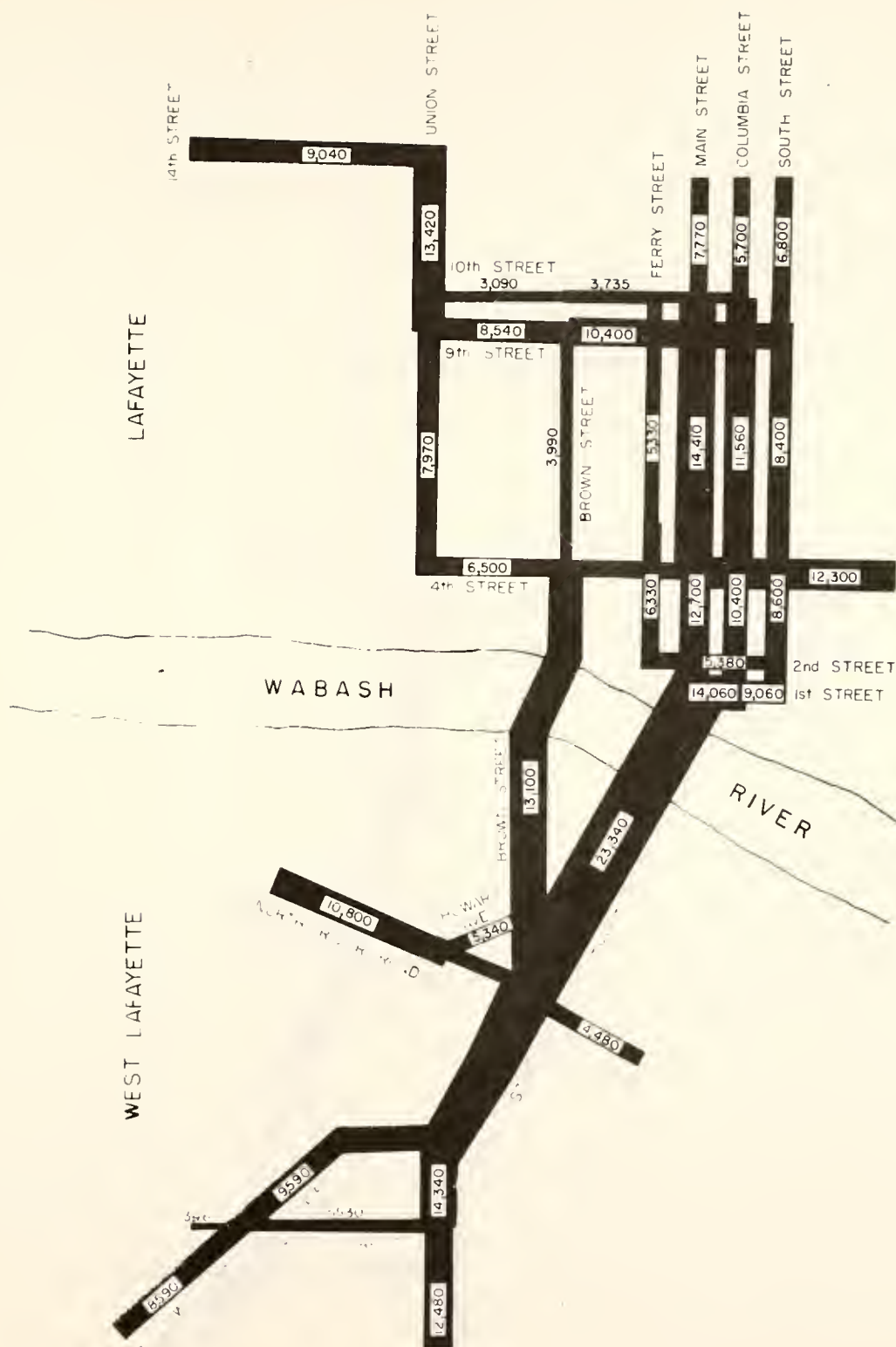


Figure 20. Main Artery Traffic Volumes - 1960.





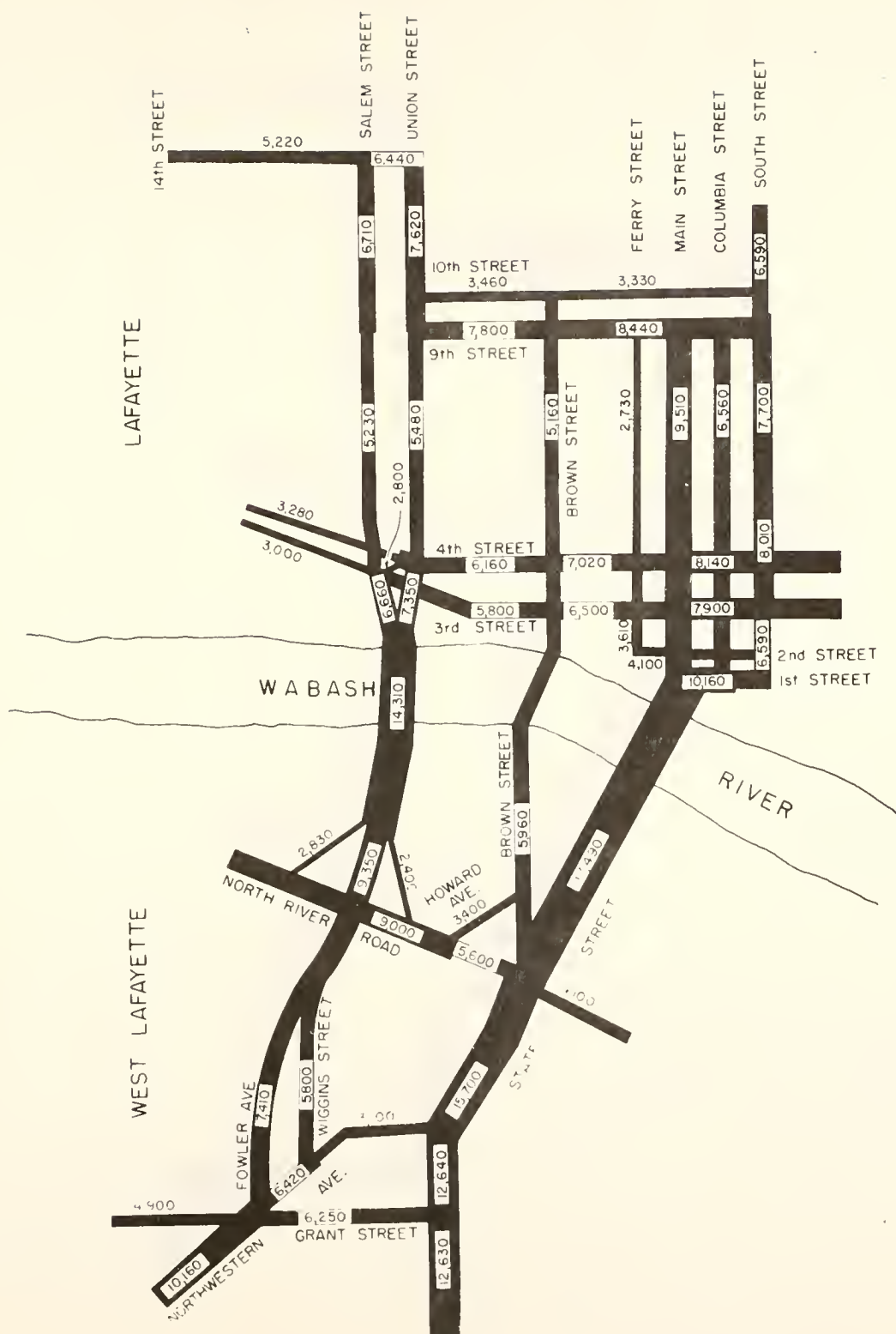
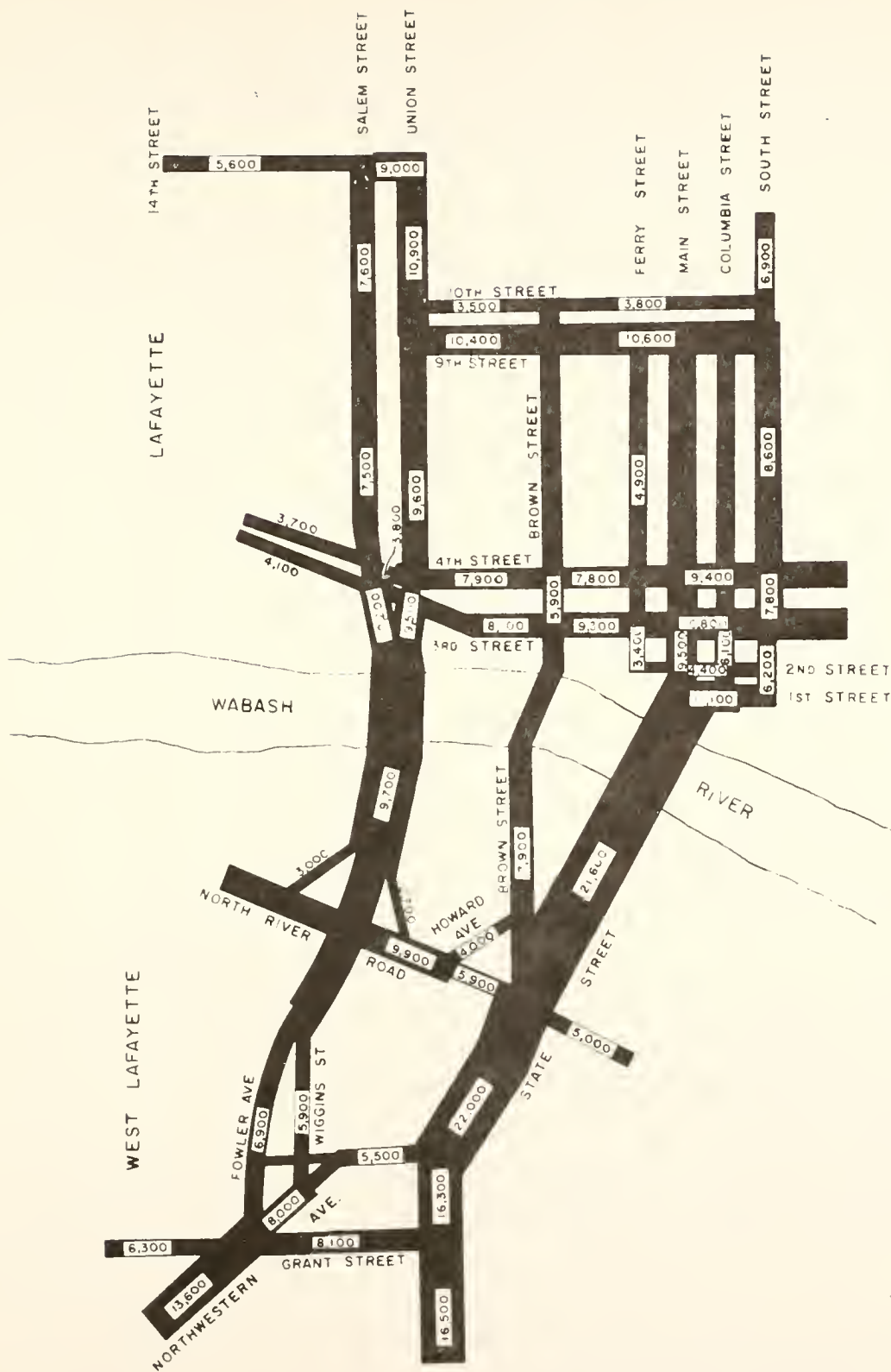


Figure 21. Main Artery Traffic Volumes - 1961.







The percentage increase in the accident rate for the period 1957-1959 to the period 1961-1963 was much less than the increase from 1961-1963 to 1964-1967 even though travel increased ratehr steadily. The reason for the smaller increase seems to be the Harrison Bridge, opened in 1960, since it was the only significant change in the central arterial system during the periods studied.

An important measure of the economic effects of a highway improvement is the change in land use and value that occur during and after its construction. However, in urban areas there exist many factors which may influence development. In the studies made, attempts were made to isolate and analyze the influence on land developemnt and land value change exerted by the bridge.

Land use patterns of the land that would be most effected by the Harrison Bridge were obtained in 1959 from field reconnaissance (see Figures 23 and 25). In 1962 another survey was taken. At that time few land use changes were noted. The major land use changes that had occurred resulted from the destruction of existing development in connection with the construction of the bridge. Data was again obtained in 1967 and land use maps were drawn (see Figures 24 and 26).

The land use map of the West Lafayette study area in 1959 shows that most of the area west of North River Road was residential. The land east of North River Road was mostly vacant because it was low bottom land and was occasionally under water. The area would have to be filled for development and this was uneconomical. But with the addition of the Harrision Bridge, this bottom land became very accessible to large volumes of people who could avoid the congested parts of both Lafayette and West Lafayette.

Two types of development occurred in the bottom land. North of the Harrison Bridge a series of multiple dwellings were constructed at a cost of \$3,000,000. Fill was taken from areas of a parcel of land that was used for that purpose. South of the Harrison Bridge, commercial development along Brown Street moved northward towards the new bridge. Two multiple dwellings were also constructed west of North River Road on the bridge approaches. These have been constructed on parcels of land which were partially taken for right-of-way purposes for the bridge.

The 1959 land use map of the Lafayette study area shows a concentration of light industry, public utilities, and railroad property from Fourth Street to the Wabash River. The rest of the study area contained single and double



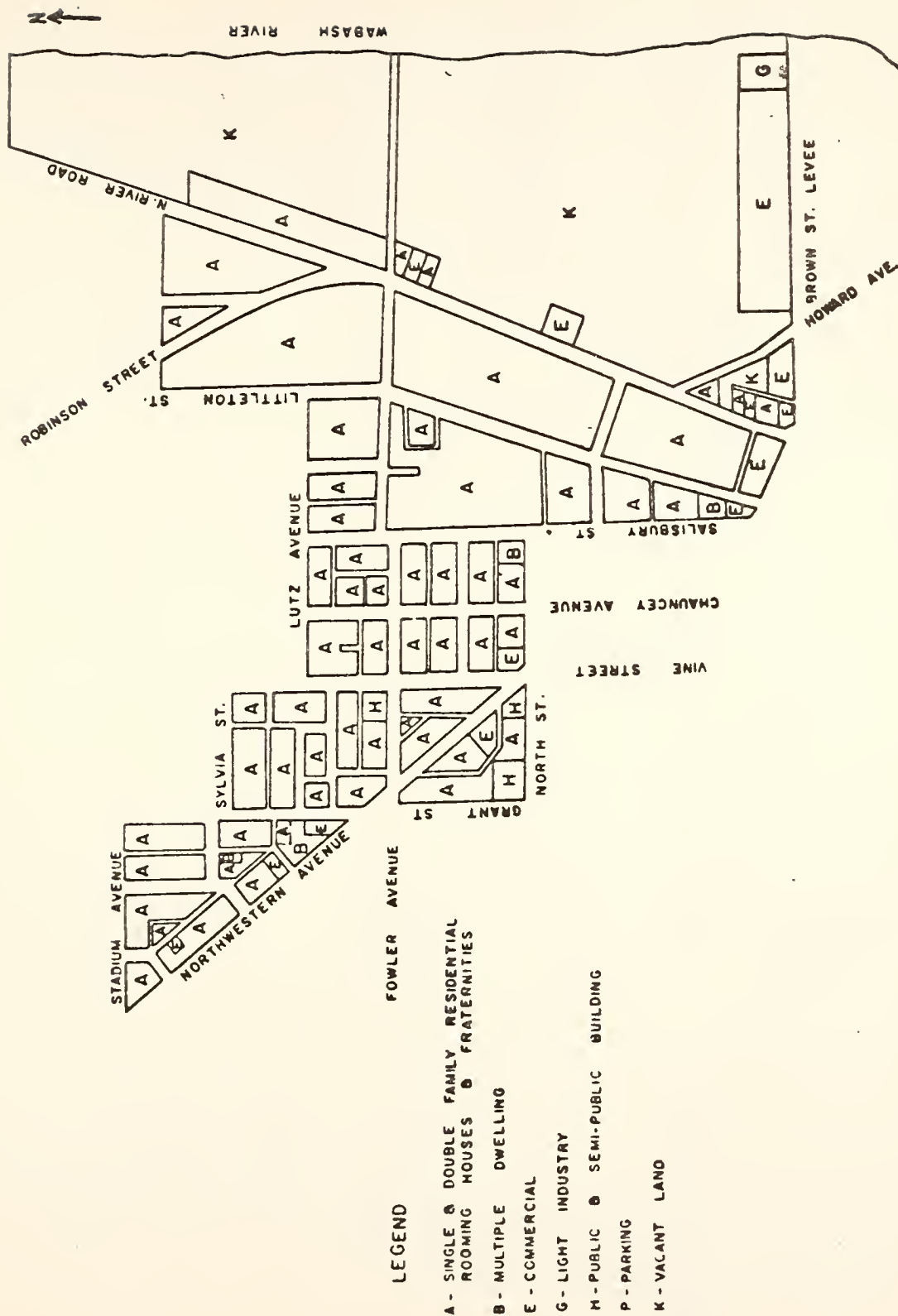


Figure 23. Detailed Land Use Study Area - West Lafayette 1959.





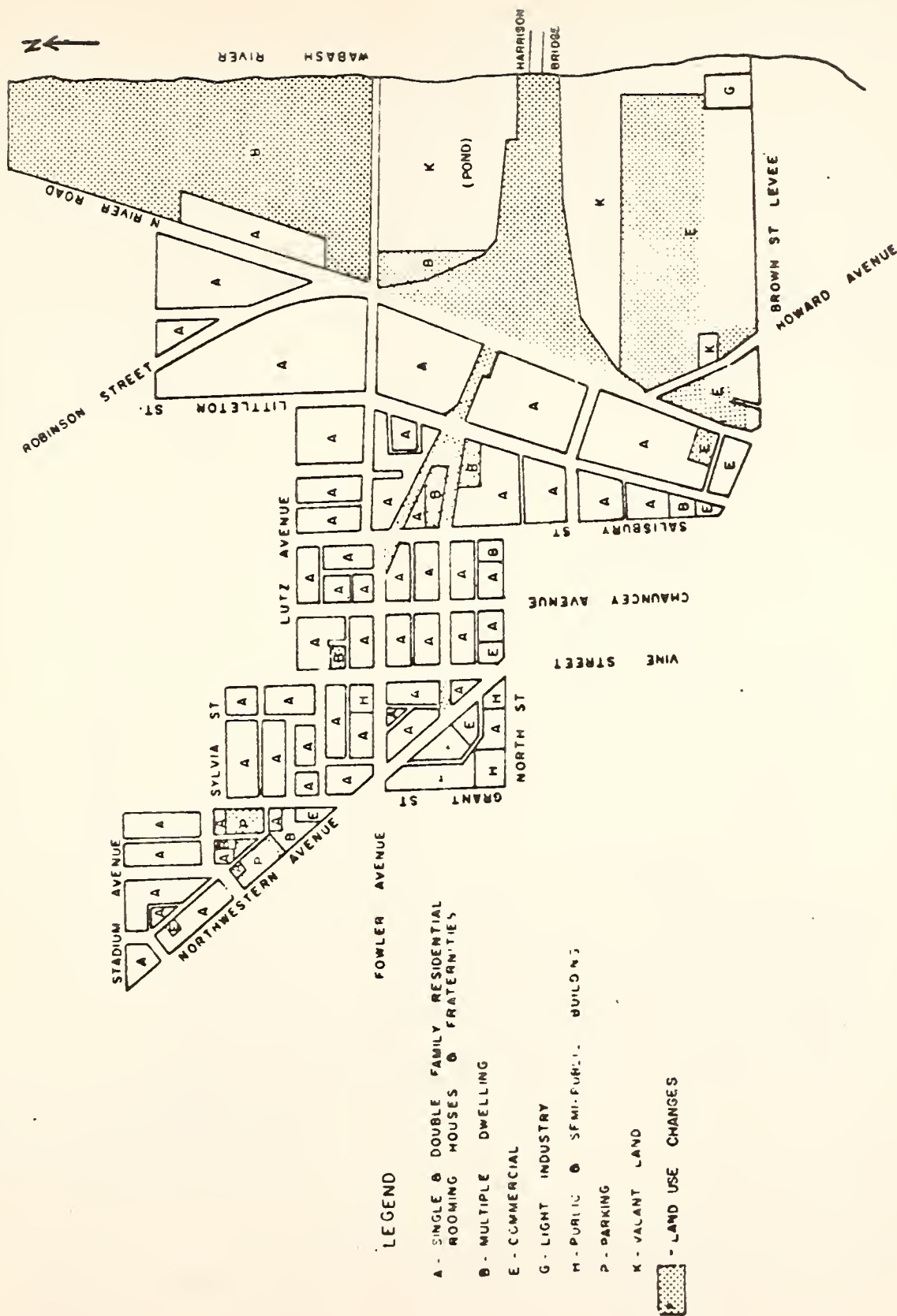


Figure 24. Land Use Changes in Study Area, 1959 to 1967, West Lafayette.



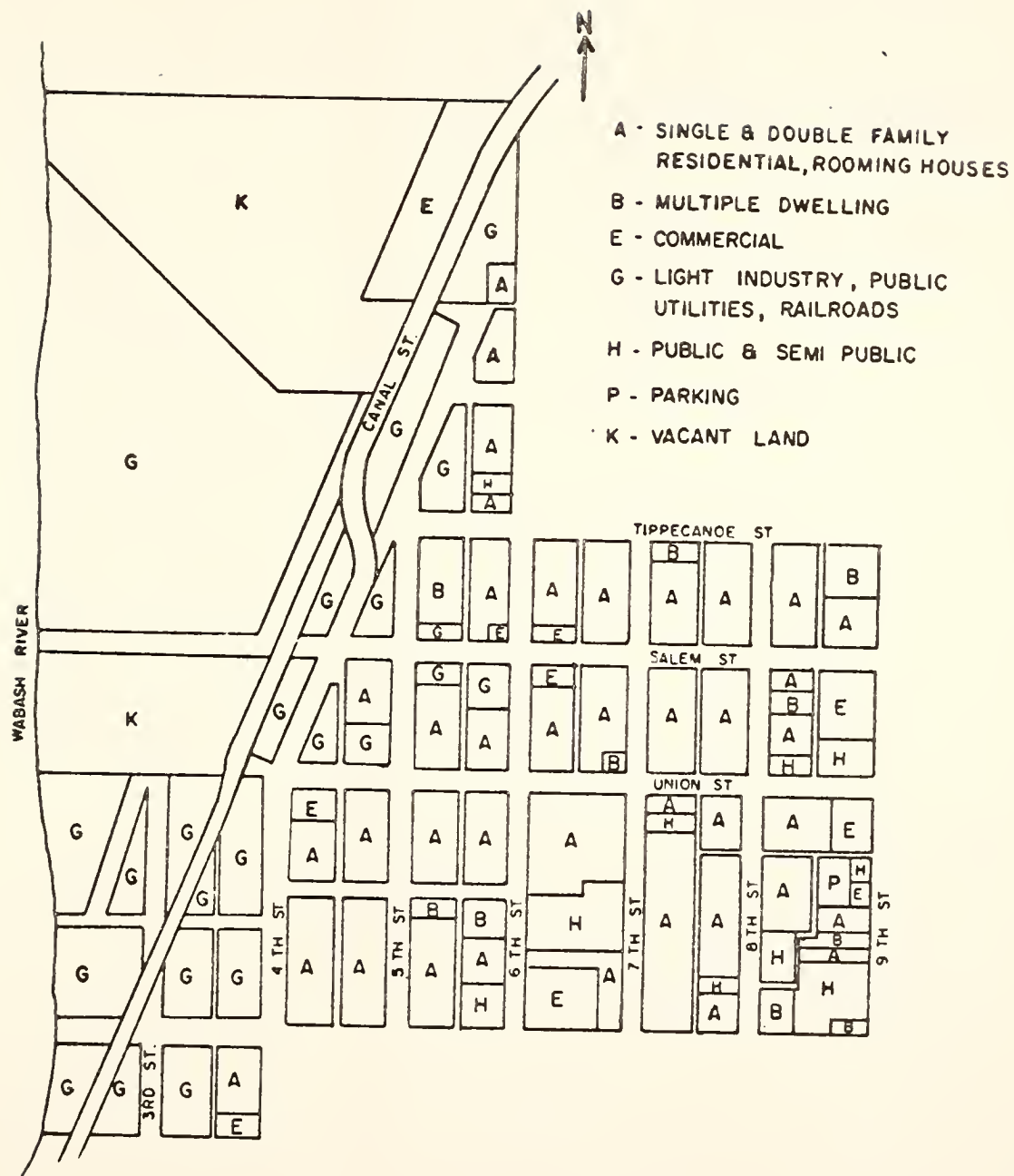


Figure 25. Detailed Land Use Study Area - Lafayette 1959.



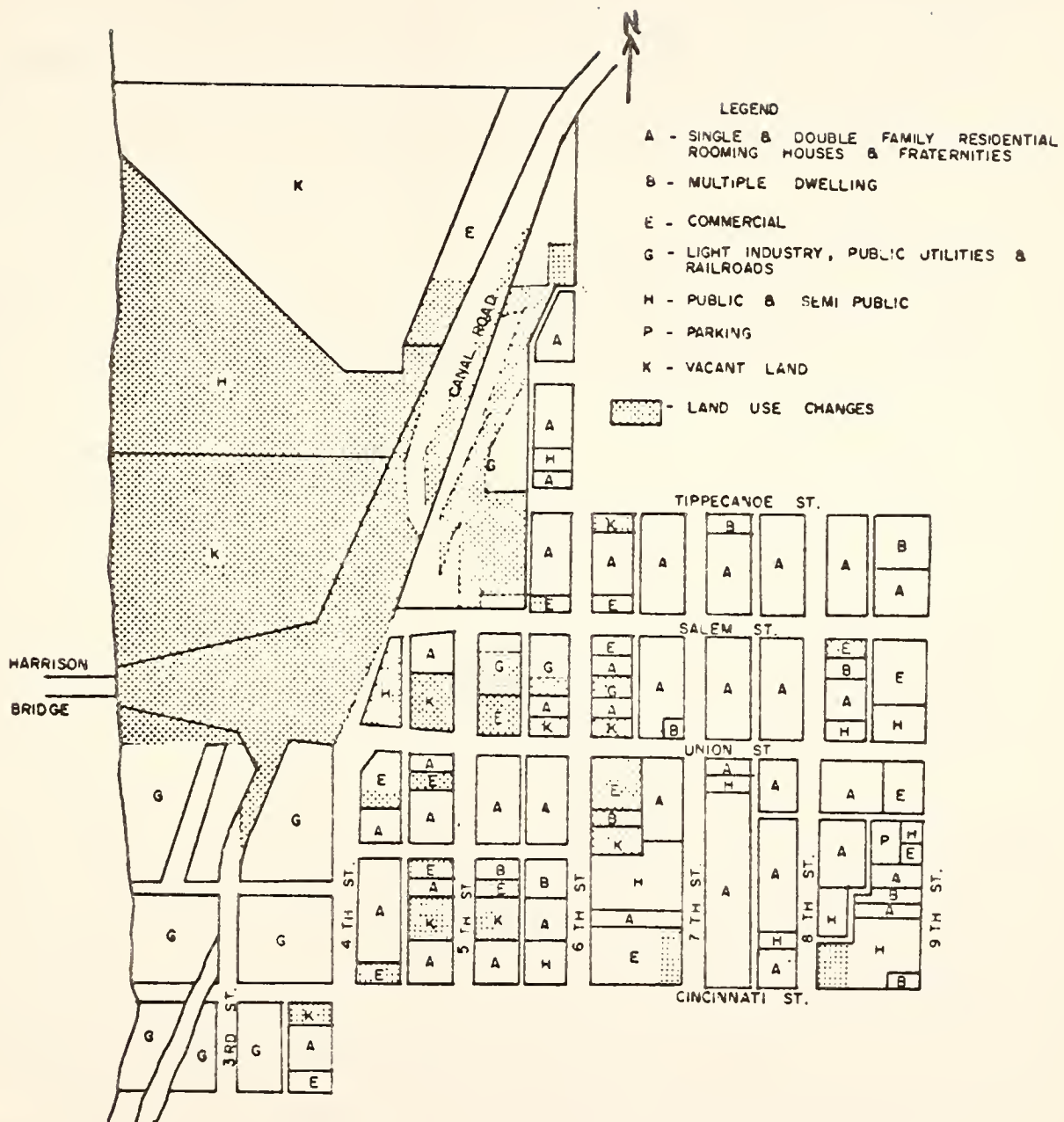


Figure 26. Land Use Changes in Study Area, 1959 to 1967, Lafayette.



family residential buildings and rooming houses with some other land use types scattered throughout.

The Lafayette land use map of 1967 shows many land use changes. Union Street and Salem Street are one way arterials leading into the Harrison Bridge. Along and between these streets there have been several changes from residential homes to commercial developments. Some of the land north of the bridge between the Wabash River and Canal Road has been made into a public park. Most of the other land use changes that have occurred in the area are mainly from residential to commercial uses.

The Harrison Bridge has also undoubtedly had an effect on land use development and value in more distant parts of both cities. Access of West Lafayette residents to the Market Square Shopping Center was materially improved and probably has resulted in accelerated development of that center. Similar effects on other commercial property along or near Union Street are probable.

A summary was made on the effect of the Harrison Bridge on assessed evaluation of property. Parcels that underwent land use changes in the study area since construction of the bridge were tabulated (see Table 2). The assessed value of property taken for right-of-way for the bridge was estimated by taking one third of the total state appraisal of the land and the improvements taken. Since assessed values noted were as of March 1 for 1967, some current values are incomplete because of development completed or in progress since that date. These values are starred twice in the table.

The total assessed value of property that underwent land use change between 1959 and 1967 shows an increase of \$512,772. Thus even though assessed values and therefore tax revenues showed a decrease immediately after the right-of-way for the bridge was assembled, seven years after construction of the bridge assessed values had increased more than the original decline and considerable additional increase is still occurring. The bridge undoubtedly had a beneficial effect on assessed values in the study area.

The results of a study of remainder parcels from the acquisition of right-of-way for the Harrison Bridge produced expected results. Where there was a land use change there was a significant increase in land value. But land that contained single family residential structures both before and after construction of the bridge experienced little change in value.





Table 2. Assessed Value of Property Involved in Land Use Changes in Study Area.

Parcel	1959	1967
Right of Way Taken	\$542,123*	0
West Lafayette Parcel 1	35,295	\$11,295**
2	1,725	12,410
3	3,000	36,070
4	2,060	20,410
5	8,000	830,000**
6	2,000	15,160
7	1,000	7,530
8	200	3,230
9	2,000	13,950
10	1,570	2,520**
11	500	600**
12	500	600**
13	75	1,000
14	3,425	163,120
Lafayette Parcel 1	2,600	600
2	1,150	2,880
3	3,400	3,400
4	11,870	2,720
5	5,890	3,900**
6	4,485	5,440**
7	7,060	23,640
8	5,560	1,410
9	7,245	840
10	1,110	3,200
11	6,720	2,490
12	500	6,340
13	2,375	530
14	2,300	2,260
15	4,665	5,630**
Total	\$ 670,403	\$1,183,175**

\* Estimated by taking one third of the total state appraisal of the land and improvements taken.

\*\* Incomplete because of development in 1967 after assessment date of March 1.



## MODELING THE IMPACT OF HIGHWAY IMPROVEMENTS

Most previous attempts at considering the economic impact of highway improvements on land values were limited to descriptive before-and-after accounts of the observed impact. Such before-and-after measures of impact can of necessity be made only after the completion of the highway improvement. Unfortunately there are no generally accepted techniques for predicting the probable impacts of various highway decisions on land values at the time these decisions are made. To fill this need, Isibor developed a predictive model which would estimate the economic impact of highway improvements on land parcels.

In his research, sale price was used as an indicator of impacts that occur to land parcels following such highway improvements. This decision was made because sale prices tend to be more objective than other indicators, such as opinion surveys. Sale prices avoid most of the problems associated with interpreting the real attitudes of respondents and they are based on verifiable contracts rather than estimates or responses that may sometimes be self-serving or otherwise inaccurate.

The study utilized data from the states of Indiana and Florida. The Florida data were made available through the cooperation of the Bureau of Public Roads and were taken from two studies conducted by the Florida State Road Department. From each of these two Florida studies, a random sample of fifty parcels was selected for use in the research. One shortcoming of this data was the absence of parcels in urban fringe areas. Data from the State of Indiana were obtained from the work of Stover mentioned previously. Of the sixty-six Indiana study parcels, only thirty had sufficient data on all of the selected variables to permit their use in the modeling aspects of the research.

The method employed in the model evaluation phase of the research was that of multivariate linear regression analysis. The BIMD02R stepwise regression package program available at Purdue was used. Two sets of models were developed; there are identified as the I-set and the IF-set. The I-set used data from the state of Indiana and the IF-set used data from the states of Indiana and Florida. Each of these sets contains ten models, identified in Table 3.



Table 3. Identification System for Developed Models.

MODEL NAME	DEPENDENT VARIABLES			IDENTIFICATION SYSTEM							
	DIFFERENCE IN CONSTANT DOLLARS (DDIFF)	PERCENT DIFFERENCE (PDIFF)	RECOVERY RATE (RVALUE)	SIZE X <sub>4</sub>	TYPE OF AREA TYPE OF ACCESS						
					URBAN Z <sub>18</sub>	FRINGE Z <sub>19</sub>	RURAL Z <sub>20</sub>	FULL Z <sub>21</sub>	PART. Z <sub>22</sub>	NONE Z <sub>23</sub>	Z <sub>24</sub>
CC-1	•			•	•	•	•	•	•	•	•
CC-2	•			•	•	•	•	•	•	•	•
CC-3	•			•	•	•	•	•	•	•	•
PC-1		•		•	•	•	•	•	•	•	•
PC-2		•		•	•	•	•	•	•	•	•
PC-3		•		•	•	•	•	•	•	•	•
RR-1			•	•	•	•	•	•	•	•	•
RR-2			•	•	•	•	•	•	•	•	•
RR-3			•	•	•	•	•	•	•	•	•
RR2A			*	•	•	•	•	•	•	•	•

\* LOG(R)



Table 3. Identification System for Developed Models.

MODEL NAME	DEPENDENT    VARIABLES			INDEPENDENT    VARIABLES																																		
	DIFFERENCE IN CONSTANT DOLLARS (DDIFF)	PERCENT DIFFERENCE (PDIFF)	RECOVERY RATE (RVALUE)	QUANTITATIVE											QUALITATIVE																							
				SIZE X <sub>4</sub>	TIME X <sub>5</sub>	LOG (SIZE)	LOG (TIME)	SIZE			TIME			HIGHWAY			TYPE		LAND		USE		CATEGORY			TYPE		OF		AREA		TYPE		OF		ACCESS		
								SIZEA Z <sub>6</sub>	SIZEB Z <sub>7</sub>	SIZEC Z <sub>8</sub>	TIMEA Z <sub>9</sub>	TIMEB Z <sub>10</sub>	TIMEC Z <sub>11</sub>	INTERS. Z <sub>12</sub>	PRIM. Z <sub>13</sub>	SEC. Z <sub>14</sub>	RES. Z <sub>15</sub>	COMM. Z <sub>16</sub>	AGRIC. Z <sub>17</sub>	VAC. Z <sub>18</sub>	URBAN Z <sub>19</sub>	FRINGE Z <sub>20</sub>	RURAL Z <sub>21</sub>	FULL Z <sub>22</sub>	PART. Z <sub>23</sub>	NONE Z <sub>24</sub>												
CC-1	●			●	●									●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
CC-2	●					●	●							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●		
CC-3	●							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
PC-1		●		●	●									●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
PC-2		●				●	●							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
PC-3		●						●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RR-1			●	●	●									●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
RR-2			●			●	●							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	
RR-3			●					●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●
RR2A			*			●	●							●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	●	

\* LOG(RVALUE)





The general model is of the form:

$$Y = \beta_0 + \sum \beta_i \alpha_i + \sum \beta_j \gamma_j + \varepsilon$$

where

$Y$  = dependent variable

$\alpha_i$  = linear independent variable

$\gamma_j$  = dummy independent variable

$\beta_0$  = constant term

$\beta_i, \beta_j$  = regression coefficients

$\varepsilon$  = error or the net effect of contributions to the value of the dependent variable attributable to other variables not included in the model.

To calibrate this assumed functional form, the empirical regression coefficients  $b_0, b_1, \dots, b_n$  (estimates of  $\beta_0, \beta_1, \dots, \beta_n$  respectively) were determined from sets of observations using the least square criterion.

Fluctuations in land values were selected as indicators of what happens to a land parcel when the road situation changes. Three measures of these fluctuations were used in the research as dependent or response variables. The first measure was change in land value in constant dollars (DDIFF), which can be expressed as:

$$Y_H = [LV_A - LV_B] - Y_G$$

where  $Y_H$  = total observed change in land value

$Y_G$  = general change in the land market in the area attributable to other causes apart from the highway improvement

$LV_B$  = land value in constant dollars before the opening of the highway improvement

$LV_A$  = land value in constant dollars after the opening of the highway improvement



The second measure, the percent change in land value (PDIFF), is of the same form as the first except that the change is expressed as a percentage of the before value. The second measure takes the form:

$$P_H = \left[ \frac{LV_A - LV_B}{LV_B} \right] 100 - P_G$$

where

$P_H$  = percent difference in land value attributable to the improvement

$P_G$  = general percentage change in the land market in the area not attributable to the highway improvement

The third measure, the recovery rate (RVALUE), is defined as:

$$R = \left[ \frac{P_A}{P_B} \right] 100$$

where

$R$  = recovery rate expressed as a percentage

$P_A$  = unit price of remainder sold (dollars per acre)

$P_B$  = unit price of original parcel before severance

The following independent variables were used after observing the results of the Public Roads Severance Effects Bank:

1. Size of parcel (acres)
2. Time elapsed between completion of highway improvement and sale of parcel (months)
3. Type of highway improvement (interstate, primary or secondary)
4. Type of land use (residential, commercial, vacant or agricultural)
5. Type of area (urban, urban fringe, or rural)
6. Type of access control (full, partial, or none)

Using the CDC 6500 computer, results showed that models developed under the I set were statistically superior to those generated under the IF set. Since the same criteria was used in building these models, comparisons were limited to their statistical showings as reflected by their coefficients of multiple determination and their percent standard errors of estimate. Table 4 gives a comparative summary of the models developed in both sets.



Table 4. Comparative Statistics for All Developed Models.

MODEL NAME	COEFFICIENT OF MULTIPLE DETERMINATION	COEFFICIENT OF VARIATION	NUMBER OF INDEPENDENT VARIABLES	$\left(\frac{F_o}{F_c}\right)$
I - CC1	0.8542	112.13%	11	4.6
IF-CC1	0.3064	203.63%	9	—
I - CC2	0.8631	108.65%	11	4.9
IF-CC2	0.3394	199.56%	10	—
I - CC3	0.8725	111.20%	13	4.0
IF-CC3	0.2987	204.75%	9	—
I-PC1	0.8293	125.00%	11	3.3
IF-PC1	0.4574	221.48 %	11	—
I - PC2	0.8325	120.51%	10	4.0
IF-PC2	0.4640	219.19 %	10	—
I - PC3	0.8301	132.28%	13	2.5
IF-PC3	0.4569	222.96 %	13	—
I - RR1	0.8293	105.24 %	11	3.3
IF-RR1	0.2434	220.36 %	8	—
I - RR2	0.8325	101.45%	10	4.4
IF-RR2	0.2709	218.13 %	10	—
I - RR3	0.8301	111.35%	13	3.2
IF-RR3	0.2363	222.31%	9	—
I - RR2A	0.7796	116.50%	8	4.4
IF-RR2A	0.2404	22.06%	10	—



As seen in Table 4, models in the I set that used DDIFF as their dependent variable yielded the highest value of  $R^2$ . In fact of all the models developed, models I-CC3, I-CC2, and I-CC1 occupy the first three positions in that order of preference based on  $R^2$  values.

The improvements of models I-CC2 and I-CC3 over model I-CC1 are of special significance. The relationship between the dependent variable and the two independent variables size and time was found to be non-linear. Model I-CC2 used logarithm transformations to improve linearity while model I-CC3 used a dummy variable technique. Both ways improved the coefficient of multiple determination ( $R^2$ ) slightly, but the dummy variable provided a more useful tool for treating curvilinearity in the quantitative variables.

One criterion sometimes used for evaluating the adequacy of a regression equation for predictive purposes is that a regression equation can serve as a satisfactory predictor if the observed F-ratio is about four times the selected percentage point of the F-distribution. This criterion was applied to models in the I set to test their usefulness for predictive work. An  $\alpha$  value of 0.05 is often usually used in engineering work as the risk level and was used here.

The ratios of F values observed ( $F_o$ ) from each I set model to the critical F values ( $F_c$ ) was computed and are tabulated in Table 4. This shows that six of the ten I set models satisfy the "four times" rule. On this basis, these six models merited further consideration as candidates for the "best" model.

Ideally an impact model is desired that has the following qualities:

1. Contains those variables which are logical in terms of highway impacts.
2. Has as high a coefficient of multiple determination ( $R^2$ ) as possible.
3. Has as low a coefficient of variation (C.V.) as possible.
4. Contains as few variables as possible.

Values of  $R^2$ , C.V. and the number of independent variables included in each model are summarized in Table 4. This Table shows that among the I set of models, model I-CC3 has the highest  $R^2$  value and that model I-RR2A the lowest. But model I-RR2A has the lowest C.V. value while model I-CC3 has a relatively larger C.V.

The problem of selecting the best model therefore reduces to making a decision on either of models I-RR2A or I-CC3. However the only consideration model I-RR2A has in its favor is its low coefficient of variation. Model I-CC3 not only has the highest coefficient of multiple determination but it also is easier to work with than I-RR2A. This is so because model I-CC3 uses DDIFF





as its dependent variable. One does not normally encounter the computation involved in preparing the data for the dependent variable, logarithm of the Recovery Rate, used by model I-RR2A.

Therefore on the basis of its high coefficient of multiple determination and the ease with which its input data can be prepared, model I-CC3 is probably the best overall model for the Indiana data.

Beta coefficients were used to provide a means for measuring the relative importance of the individual independent variables in determining the dependent variable. Values for beta coefficients computed for the independent variables used in this research are tabulated in Table 5 for each of the developed models of the I set. These coefficients indicate the expected increases in the dependent variables resulting from an increase of one standard deviation in each independent variable.

An examination of Table 5 shows that for each model the variable denoting highway type had the highest beta coefficient indicating that this variable was the most important of all the independent variables considered. Following highway type in order of importance for the Indiana data, were type of area, land use type, type of access control, time after the construction of the highway improvement and size of parcels.

Because of the limited data available for the development of the models in the I set, it cannot be stated that the relative importance of the independent variables to changes in land value is in general as quantified in Table 5. The findings of Table 5, however, are indications of the relative importance to changes in land value of the independent variables. Highway type, type of area and type of land use appear to be most important with type of access and time of sale of lesser importance and size of tract relatively unimportant.

In summary, the good statistical showing of models developed from the Indiana data suggests that with a stronger data base relatively simple models can be constructed to predict impact of highway improvements on land value.



Table 5. Values of Beta Coefficients for Variables in Each Model.

VARIABLES							
MODEL IDENTIFICATION	$\beta$	HIGHWAY TYPE	TYPE OF AREA	TYPE OF LAND USE	TYPE OF ACCESS	TIME	SIZE
	I-CC1	0.56	0.55	0.39	0.34	0.10	0.05
	I-CC2	0.61	0.56	0.37	0.33	0.13	0.12
	I-CC3	0.58	0.57	0.35	0.32	0.17	0.06
	I-PC1	0.66	0.60	0.57	0.27	0.12	0.04
	I-PC2	0.70	0.58	0.54	—	0.13	0.03
	I-PC3	0.65	0.60	0.63	0.32	0.12	0.03
	I-RR1	0.66	0.60	0.55	0.32	0.13	0.04
	I-RR2	0.70	0.58	0.49	—	0.13	0.03
	I-RR3	0.71	0.60	0.63	0.30	0.11	0.02
	I-RR2A	0.71	0.57	0.48	0.32	—	0.27

Date		Description		Amount	
1890	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	
1891	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	
1892	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	
1893	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	
1894	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	
1895	Jan 1	Balance		100.00	
	Feb 1	Interest		5.00	
	Mar 1	Interest		5.00	
	Apr 1	Interest		5.00	
	May 1	Interest		5.00	
	Jun 1	Interest		5.00	
	Jul 1	Interest		5.00	
	Aug 1	Interest		5.00	
	Sep 1	Interest		5.00	
	Oct 1	Interest		5.00	
	Nov 1	Interest		5.00	
	Dec 1	Interest		5.00	

## IMPACT OF A MAJOR INTERSTATE INTERCHANGE

As one portion of this research project on highway impact studies in Indiana, the effect on land value of construction of the interchange between I-65 and I-465 at the northwest edge of Indianapolis was studied. Sale prices for the years 1960 through 1967 of property within one mile of the four adjacent service interchanges to this interchange were obtained. As location of the highway facilities had been announced during the period 1958-1962, before values of the property were assumed to be the 1960 assessed values. Sales during the study period for which needed data could be collected concerned a little over 1100 acres, a very small portion of the total study area. Ninety nine parcel sales were involved. The study area was all land surrounding the study interchange and included that within approximately one mile of the nearest interchanges on each leg of the I-65 and I-465 interchange (see Figure 27). The four resulting interchanges, of course, were the closest locations to the study interchange that traffic could access or exit I-65 or I-465.

A summary of the findings of this portion of the Study was as follows:

1. The analysis of land value changes indicated that one impact of this major facility interchange and its adjacent interchanges had been an increase in land values with the amount of increase decreasing with distance from an interchange. The interchanges closest to the city center (Indianapolis) had the largest increases in land value.
2. One interchange which did not have complete access and egress facilities appeared to have lesser land value increases than it would have had if it had been a complete interchange.
3. Land parcels of less than five acres averaged higher land value increases per acre than larger parcels but also had much greater variance of land value change.
4. There was no apparent extra increase in land value for those parcels which had good access to two interchanges.
5. Because the major growth of Indianapolis had not as yet reached the study area by 1967, there had been very little actual land use change in the interchange area. It was apparent, however, that speculation of such development in the future had resulted in land sales within the area and in increases in land value.





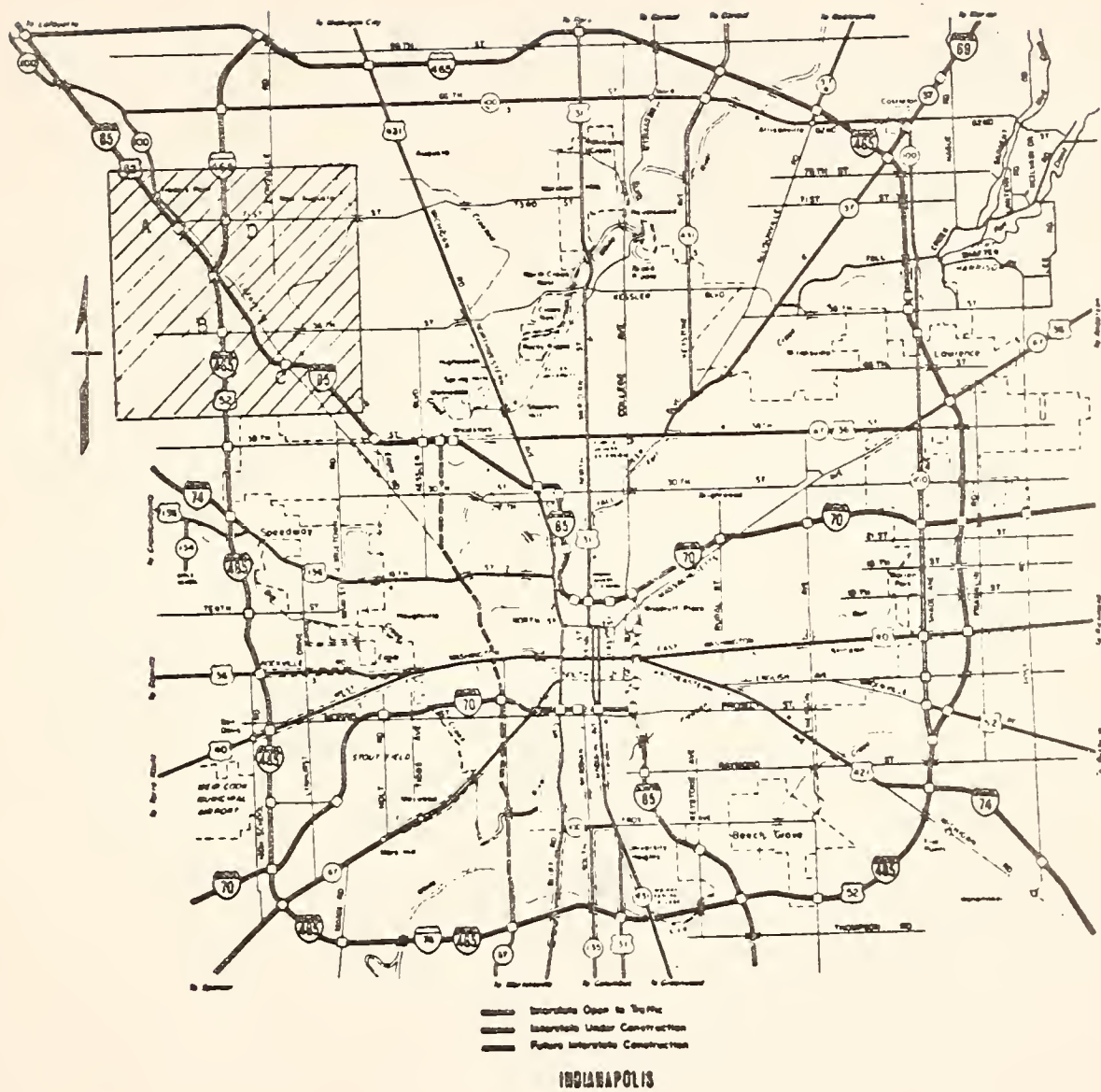


Figure 27. Location of Study Area.







